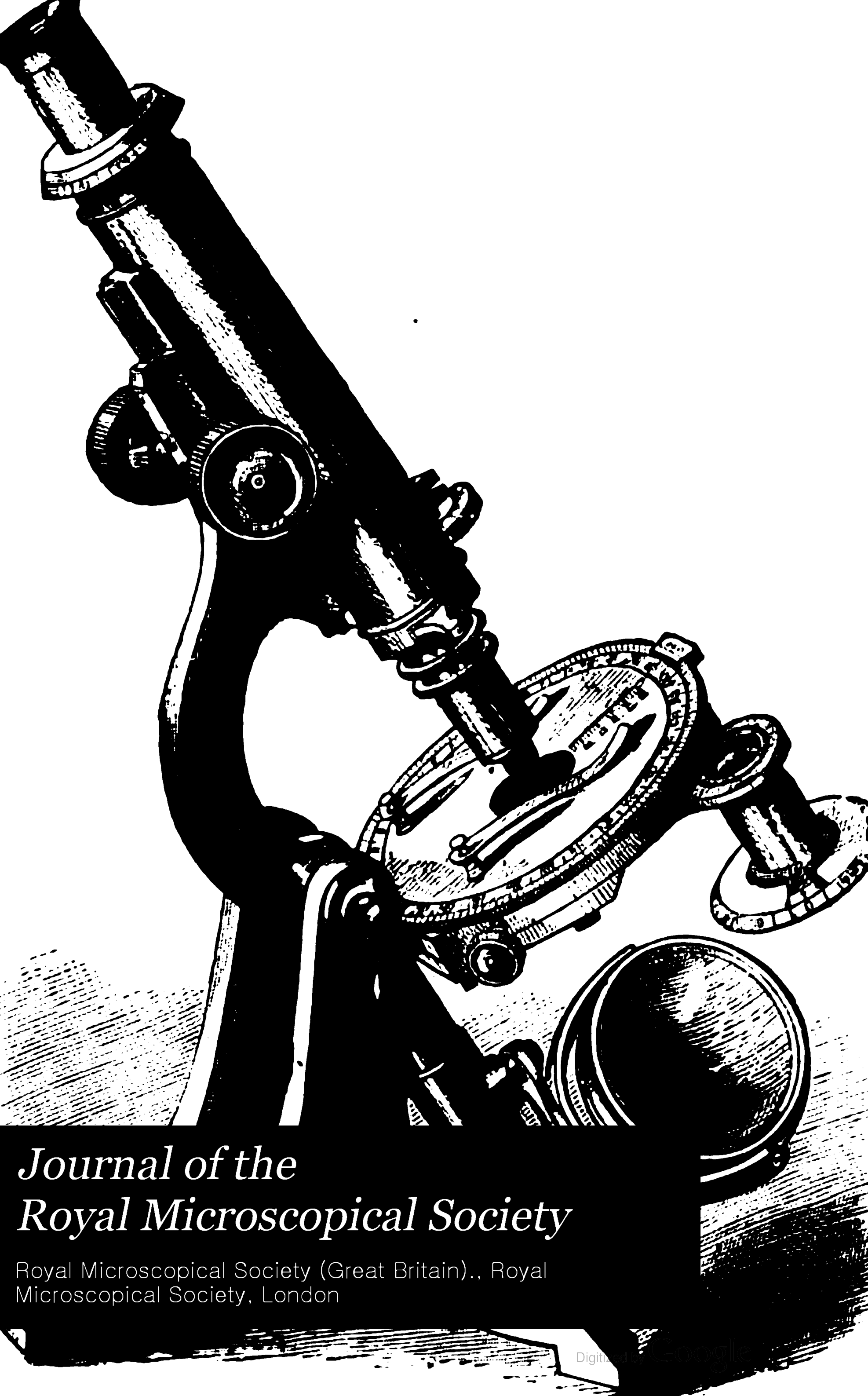

Journal of the Royal Microscopical Society

Royal Microscopical Society (Great Britain)., Royal Microscopical Society, London

JOURNAL

OF THE

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with the plates

ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A RECORD OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.

Edited, under the direction of the Publication Committee, by

FRANK CRISP, LL.B., B.A., F.L.S.,

ONE OF THE SECRETARIES OF THE SOCIETY.

VOL. II.

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PREFACE.

THE substantial increase during the present year in the finances of the Society, has rendered it possible to increase the quantity of matter in the Journal, and it is hoped it will be found to be improved in quality also.

In addition to the "TRANSACTIONS" and "PROCEEDINGS" of the Society, the "BIBLIOGRAPHY" and "RECORD" now form a large part of each number. The former provides a classified Index, in English, to the contents of upwards of three hundred British and Foreign Scientific Journals and Transactions,* whilst the latter consists of abstracts of or extracts from the more important of the articles noted in the Bibliography.

The object of this part of the Journal is to meet a wish which has been for many years expressed by the Fellows—not only those resident in the country, to whom the Library is less accessible, but those in London also—that steps should be taken for obviating to some extent the difficulty that has hitherto existed (owing to the great development in modern times of Periodical Scientific Literature) in ascertaining what is being done by Biologists of this and other countries.

Whilst the Annual Records published in this country and abroad (all of which are to be found in the Library) are invaluable as books of reference beyond anything to which a Journal issued bi-monthly could attain, the feeling has been that a more *readable* account of the results of research would be useful, and, if possible, one not so much out of date. As an instance, Mr. Geddes' very interesteng researches on Chlorophyll in the Green Planariæ may be referred to. In ordinary course a more or less brief reference to this observation would appear in the Annual Summaries of the second (in a few cases the first) year after its announcement. It is obviously very desirable that the Fellows should, in such a case,

* In a memorial recently presented to Professor E. Coues, of the United States, signed by Professors Flower and Huxley, Mr. Darwin, and others, the memorialists say:—"The want of indexes to the ever-increasing mass of Zoological literature has long been felt by all workers in every department of science, but the enormous labour of compilation has hitherto deterred many from undertaking a task so appalling."

be in possession of fuller and earlier information of the author's views.*

As the Society's domain includes the *Invertebrata* and the *Cryptogamia* generally, with the *Embryology* and *Histology* of the higher Animals and Plants, and *Microscopy* (properly so called), the Bibliography and Record extend to those subjects also.

The difficulty that has hitherto prevented a nearer approach to completeness in the Bibliography—that of perfecting arrangements at short notice for obtaining ready access to all the Journals and Transactions which it is intended ultimately to include—is now, it is hoped, in a fair way to be overcome.

With regard to the Record, the matter stands on a different footing, the greater or less completeness in this case necessarily depending upon the Society's finances. Whilst the fullest use has been made of the means at command, the result falls short of what it is hoped will ultimately be accomplished. It requires, however, a larger expenditure than the Society can at present prudently devote to that purpose.

It will have been obvious that the production of the later numbers of the Journal was beyond the powers of any one person (at least when the only time that could be devoted to it was by way of relaxation from engagements having a primary claim); and the Society have been fortunate in obtaining the assistance of Mr. T. Jeffery Parker, Mr. A. W. Bennett, and Professor F. Jeffrey Bell, to whose ability and energy the success of what has been accomplished is very largely due. As their share in the production of the Journal is now so important, their names will in future be associated with it.

An acknowledgment is also due to the Publication Committee (consisting of Dr. Braithwaite, Dr. Millar, Mr. Stephenson, and Mr. Stewart) for much care bestowed on the revision of the Record, and for many suggestions which have contributed to the improvement of the Journal.

FRANK CRISP.

* Whilst we fully recognize the compliment that is involved in the transfer of the foreign abstracts of the Record to other pages, and the exceptional appreciation evinced by referring to the original foreign source only (the editor evidently intending thereby to show that he is prepared to take the responsibility of having the abstracts attributed to himself), it would, on the whole, we suggest, be better to adhere to the rule which we uniformly observe, of giving *both* sources in the reference note.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY, 1879.

TRANSACTIONS OF THE SOCIETY.

I.—*On Œcistes umbella and other Rotifers.*

By C. T. Hudson, M.A., LL.D., V.P.R.M.S.

(*Read 11th December*, 1878.)

Plates I. and II.

This remarkable new species was discovered by Mr. F. Oxley last June in a pond at Snaresbrook. Mr. Oxley was so kind as to send me several specimens, but I was unfortunately prevented from giving them all the attention they so well deserved; and though I made some sketches of this Œcistes, I was unable to investigate its structure and habits in the way that I should have wished to do.

It is a large handsome species, and the specimens sent to me had made their clay-coloured fluffy homes on the leaves and in the axils of a sphagnum. The tubes, if I may call such loose structures by so precise a name, resemble those of the rotifer I described as *Melicerta tyro;* but which I think had better be

EXPLANATION OF THE PLATES.

Plate I.

Œcistes umbella.

Fig. 1.—A group of three.
„ 2.—Disk of *Œ. umbella.*
„ 3.—Disk of *Œ. crystallinus.*

Plate II.

Conochilus volvox.

Fig. 1.—A cluster.
„ 2.—An individual. *a*, spermatozoa on ovary; *b*, extremity of anus.
„ 3.—Spermatozoa (two forms).
„ 4.—Extremity of anus.
„ 5.—Winter egg in ovary (various stages).
„ 6.—Winter egg (final stage).
„ 7.—Male in egg.
„ 8.—Eye.

named *Melicerta tubicolaria*; as I have now little doubt, in spite of the errors in his figures and description, that this was the rotifer out of which Ehrenberg framed his genus *Tubicolaria*.

Nothing can be more irregular than the shapes of the homes in which these creatures dwell. They are fluffy masses of a substance secreted by the animal itself, and fortified by random gatherings of material thrown down on them by the action of the ciliary disk. Like those of all the tube-making rotifers, they have only a small cylindrical passage down their centre, up and down which the animal moves, and the material of which they are composed is continuous from the rotifer right out to the surface. By transmitted light they appear to be *hollow*; but this is not the case, and the dark-field illumination will generally enable the observer to trace the delicate material everywhere from the outer surface to the animal within. In *Floscularia campanulata* I have seen the young newly-hatched male bore his way with his long cilia from the side of his mother right out of her case; and I have also seen it die in the attempt. The most remarkable thing about *Œcistes umbella* is its disk, which is so strengthened by ribs across it in various directions, that it looks somewhat like an odd kind of umbrella. Two of these thickenings are very broad, and run across, as shown in the figure, from the ventral to the dorsal side of the disk. When the rotifer closes its disk, it naturally folds it so as to bring these stouter portions together, the thinner parts being folded within them; and, in consequence, it often has an odd square look about its head, that I have never seen in any other species of Œcistes. But this strengthening of the disk is not peculiar to it. The common *Œcistes crystallinus* has precisely the same thing, only on a much smaller scale (as may be seen in the Plate, Fig. 3), and similar thickenings are visible in *Œ. pilula*.

In *Œ. umbella* there is on either side of the disk a branched rib like a gusset; but the whole structure must be viewed in various directions and by different modes of illumination to get a clear idea of it. The central ribs, when the disk is viewed edgeways, are clearly seen to project above its surface a little.

My friend Mr. A. W. Wills found this rotifer in one of the ponds of Sutton Park, and exhibited some specimens in October at a meeting of the Birmingham Natural History Society. Mr. Wills has figured and described it in the December number of the 'Midland Naturalist,' adding to his interesting remarks some accurate measurements of a full-grown individual. From these it will be seen that *Œ. umbella* is much larger than *Œ. crystallinus*, and about twice as large as *Œ. pilula*. On a piece of alga which Mr. Wills has just sent me, the two species can be seen side by side, and form a very pretty picture. They have been living in Mr. Wills' tank, and have come to me in excellent condition in

spite of the severe weather, which seems to have killed all their brethren in the ponds.

Œ. umbella has two well-marked red eyes which can be seen on looking down through the disk; they are situated well within the animal, below the disk, and towards the dorsal side, that is, towards the side where the mouth is not.

Ehrenberg's family, Œcistina, ought of course to be included in the family of the Melicertans, but I agree with Mr. Wills that the genus *Œcistes* ought to be retained, as we have now no less than five species; viz. *Œ. crystallinus;* Mr. Davis' new pair, *Œ. intermedius* and *Œ. longicornis;* Mr. Tatem's *Œ. pilula;* and Mr. Oxley's *Œ. umbella.*

Conochilus volvox.—I had the pleasure of reading Mr. Davis' excellent paper on this most curious rotifer,* just after I had been drawing it from a few specimens which had survived the transit from London to Clifton. The creature is a bad traveller, not a single sphere remained unbroken; and indeed the tube contained no group with more than four rotifers in the cluster. In some respects this was an advantage, as it enabled me to see much more clearly than I otherwise should have done the animal's structure. First let me say that Mr. Davis' account of this rotifer is most accurate. He is quite right in pointing out that there are the usual pair of setæ-bearing antennæ, one on either side of the mouth, not *four* conical papillæ, each with a bristle, as Ehrenberg asserts. He correctly states that the line of cilia is interrupted in one part of the disk, and that the notch in the cilia is *not* where the mouth is. Mr. Davis has also most clearly shown the peculiarity of this rotifer's structure in having its mouth and anal aperture on the same side: and in its fringe of large cilia enclosing that of the small cilia as well as the mouth; instead of its being enclosed by the smaller cilia, and of the mouth's lying between the two fringes. Mr. F. A. Bedwell has given an admirable and most forcible illustration of the difference between the trochal disk of *Conochilus* and that of *Melicerta* in his capital paper on the building apparatus of *Melicerta ringens.*

The arrangement of the parts is so curious in *Conochilus*, and so exasperating to a classifier, that I may venture to suggest even a third way of considering them. If a crochet hook were supposed to be pushed through the centre of the disk, down the middle line of the body, and hooked on to the end of the foot, then on drawing the hook right back again, the animal would be turned inside out like the inverted finger of a glove, and be pulled through its own disk; and the relative position of its organs would be nearly that of an ordinary Melicertan. In the drawing that I have given of a *Conochilus*, it will be seen that the anal aperture lies remarkably

* 'M. M. J.,' vol. xvi. p. 1.

high on the back, and that it has a curious trefoil opening. In one of the specimens I could distinctly see several spermatozoa attached to the ovary and still moving. The spermatozoa were of two shapes—or at all events along with the usual spindle-like forms were others like a curved cord with a puckered ribbon sewn all down it. Both these forms can be readily seen in the sperm sacs of the males, and both are constantly in motion. How the spermatozoa got outside of the ovary I cannot imagine—and that some were outside I am certain. The ovary, I believe, opens into the anus, and I know of no way in which the spermatozoa could escape into the perivisceral cavity.

There is a point of resemblance between *Conochilus* and the Floscules which is well worth notice. From the mastax to the mouth the alimentary canal is strengthened in an unusual way by a tube much harder than the surrounding parts. In *Floscularia campanulata* the tube hangs down from the mouth, and is constantly thrown into long slow undulations. As it is transparent, its *edges* only can be usually brought into focus, so that it looks like two waving lines or like the edges of two flat membranes, and thus it has been described. Under favourable circumstances, however, food or water may be seen to dilate it as it passes down, and I have repeatedly seen this happen in such a way as to make it obvious that the structure is really a tube. On crushing *F. campanulata* or *Conochilus volvox*, the tube will be found to remain, and even to resist the action of caustic potash along with the harder portions of the mastax.

Notommata aurita.—A few months ago I found this rotifer in great abundance in a pond near Bath. The water was swarming at the same time with free Vorticellæ of a fine dark green, speckled with brown. The bottle that I carried home with me had a very large number of these restless creatures in it, and I found them very much in my way as I was examining the Notommata, for they constantly knocked up against the rotifers, and made them withdraw the curious earlike appendages from which they derive their name, and which I was anxious to see. One thing puzzled me very much, and that was the rapid disappearance of the Vorticellæ from the bottle. The surface of the water was alive with them when I brought them home, and next morning there were not a fourth of the number to be seen. Almost all the Notommata, too, were useless for purposes of observation, for they were gorged with green food, so that their stomachs hid the other organs. The exact similarity of tint between the contents of the Vorticellæ and the stomachs of the Notommata had already struck my attention, when I thought I saw a rotifer (unluckily on the opposite side of a bit of horn-wort) holding one of the Vorticellæ. Could it be possible that these Notommata could eat the Vorticellæ? I put a large

piece of the weed, in which several specimens of both creatures were entangled, under the Microscope, and with a low power watched eagerly to see if I could catch the rotifer in the fact. After a few minutes' observation, I was inclined to reject the idea as absurd.

The Vorticellæ rushed backwards and forwards, knocked fearlessly against the rotifers, and, while evidently frightening the latter, took no sort of pains to get out of their way; in fact, behaved, as to me they always *do* seem to behave, just like animated machines. As to the slow-swimming and still slower crawling rotifer catching one of these swift rovers, the thing seemed impossible. Under any circumstances, whether swimming or crawling, whenever the Vorticella struck the Notommata, the latter either drew in his wheels, and ignominiously rolled over and over to the bottom, or if it were crawling on a bit of the weed it shrunk back, and contracted itself with every appearance of alarm.

Still there were two ugly facts unaccounted for, viz. the disappearance of the Vorticellæ, and the appearance in the stomachs of the Notommata of substance marvellously like them. I was just going to try to imprison a Notommata in a coil of cotton with one or two of the Vorticellæ, when I noticed one of the latter caught in the angle between two small stems of horn-wort. A Notommata, too, was crawling along one of the stems in its usual slow fashion. There was a chance that the sluggish creeper might get to the angle before the Vorticella darted off again on its travels. Fortune favoured me; the Vorticella kept waltzing round and round in the same spot, and the Notommata crawled on till it all but touched the Vorticella. I hoped to see the rotifer quicken its pace, or make—I will not say a *dart*, that would be too much, but at all events a *lurch* at its prey; imagine my chagrin when I saw it coolly curl round the stem and begin to retrace its steps, actually freeing the Vorticella from its prison by brushing it with its back as it crawled back again. There had not been a thousandth of an inch separating the rotifer's head from the Vorticella, and yet, in spite of its two eyes, it had not noticed it. Again, I thought of bringing in a verdict of "not guilty"; but another good look at dark green stomachs revived all my suspicions, and once more I patiently waited till another Vorticella, possibly the same, repeated its silly performance of getting into a corner and dancing there till some one should set it free. This time it was freed only too effectually. The Notommata once more crawled down to the captive, "without hurry or care," and struck its nose (if I may use the expression) against the Vorticella, just as if it were by accident. But the instant it did so it jerked up its head, and snapped at and seized its victim with its sharp jaws; and in a second I saw the whole contents of the Vorticella pouring down

the throat into the stomach of the rotifer. Guilty!—and without appeal.

There are a few observations showing that the rotifers occasionally use their maxillæ as teeth, but only a few. Mr. Gosse mentions the snapping action of those of *Synchæta mordax*. Mr. Slack saw a *Diglena* chase, seize with its jaws, and shake an anguillula that had presumed to jostle it. I have frequently seen *Hydatina senta* protrude its maxillæ, and snatch at some tempting green globule that the cilia could not quite force down the mouth; and once I saw a small *Notommata* deliberately snip the side of the cell of an alga, and suck out its green contents. On this occasion I contrived to see the catching of Vorticellæ by Notommata several times, and in each case the Vorticella was seized by the rotifer's maxillæ and its contents so completely appropriated that it was hardly possible to see the delicate film that was left after the operation had taken place.

Melicerta ringens.—Mr. F. A. Bedwell has given a most interesting and suggestive account of the building apparatus of this rotifer, in the November number of the 'Monthly Microscopical Journal' for 1877.* His description of the various currents which pass round and through this apparatus is admirable. To one point alone do I feel inclined to take any exception, and that is, to the separation of the particles into "four deflected streams" by the action of a sensitive cushion above the mastax. I quite agree with Mr. Bedwell that a first selection among the particles whirled round the groove of the disk is made by "two knotty protuberances set symmetrically one against the other" just at the ends of the collecting groove, and directly opposite to the chin; and that from these the main stream of waste material is directed in a great rush over the chin. But I think that the very feeble currents which creep along (as Mr. Bedwell has so well described) under the curved edges of his "hopper" admit at least of another explanation. If *Melicerta ringens* is fed with carmine, and the chin and its appendages steadily watched, it will be seen that on either side of the swift main stream which carries the waste particles over the chin, runs a feeble current between it and (if I may use the term) the bank; running, in fact, as already said, under the curved edges of Mr. Bedwell's "hopper," and along what Mr. Cubitt calls the "chases." In these currents are gently carried along such minute particles as are fitted to form the pellet, and they pass over the two notches at the chin into the pellet cup. About these facts I think there can be no doubt. It is the *modus operandi* only that is in question. It is of course possible that the sensitive cushion described by Mr. Bedwell may, like a skilful batsman, strike the larger particles into the centre of the stream, and the smaller ones to the sides where

* 'M. M. J.,' vol. xviii. p. 214.

the "chases" are; but I am inclined to think that the effects witnessed are rather due to the friction between the sides of the "hopper" and the stream itself. Anyone who has sat in a boat floating down a swift stream must have noticed that light floating particles on the surface pass him, that they are going at a quicker rate than his boat is; and that anything like a free buoy, which in still water would float upright, is in the swift stream tilted *forward* as it floats, its submerged end as it were dragging behind the free top. All this is clearly due to the fact that the upper portions of the river are flowing faster than the lower, which are hindered by the friction of the water against the channel itself. In the same way the side portions of the stream close to the banks move perceptibly slower than those farther off, and very much slower than the centre of the stream. The result is that while the heavier floating bodies, owing to their greater momentum, generally escape from the feebler currents if they ever get into them, the very light particles (often pushed aside and towards the banks by the heavier ones) are constantly caught and retained by the gentle currents at the side. I think then that the minute particles pass slowly along the "chases," merely because along the chases run comparatively feeble currents, owing to the retarding action of the sides of the "hopper," and especially of its curved edges.

I should be inclined to think also that the production of the peculiar form of the pellet is due to mechanical considerations out of Melicerta's control. For instance, the pellet is frequently seen to rotate in one direction round its axis, and then after a few revolutions to rotate in the opposite direction round the same axis; and to repeat this again and again with great regularity, the coloured specks on the pellet even enabling the observer to *time* the process. Now at first sight this looks as if Melicerta had reversed the action of its cilia in the cup at its own pleasure; but I believe that there is a simpler explanation. The cilia with which the cup is lined, suddenly curving inwards in turn one after another —just as on the trochal disk—produce a vortex in one constant direction so long as the pellet is small enough to lie clear of all of them, but when it gets larger it hinders the action now of one portion of the cilia lining the pellet, now of another, by getting so close to them as to stop their blows, and then the cilia on the opposite side to the checked ones have the advantage and produce a current towards themselves, which not only makes the pellet rotate round its axis *from* the checked ones *towards themselves*, but at last draws it bodily over to the side where the cilia are free, thus checking in their turn those previously free and releasing those previously checked. Of course, the rotation is at once reversed till the pellet is drawn back to its old position, and then *da capo*. That the pellet is not truly spherical is, I think, mainly

due to the fact that it is made in a cup into which material slowly trickles at the edge. The greater portion of such material, when the pellet has reached a certain size, would be whirled on to it before reaching the bottom of the cup — and the nearer any portion of the pellet was to the bottom, the less its chance of getting fresh accretions. Hence, in the main, arises its subconical shape. Such a shape would be readily thrown by the motions of Melicerta out of its first position, in which its longer axis is at right angles to the lower portion of the cup, into a new position in which that axis lies across the cup; and once in this position it would not be very easy to get out of it. The action of the cilia on it in this new position would now obviously tend to make it rotate round its longer axis, as those cilia opposite to the extremities of that axis would have their action checked by the pellet itself. Moreover, the fresh material would *now* tend to be mainly arranged round the pointed end, as it would be only those cilia which were on either side of it that would have perfectly free action; those opposite the larger end being constantly checked by the pellet's touching them. This would finally lead to a roughly cylindrical pellet of the usual form.

But I am afraid that I have already pursued the subject too far for the reader's patience; I will only say, in conclusion, that I heartily sympathize with Mr. Bedwell's appreciation of the wonders of this living atom. Whatever may be the correct explanation of the facts he so lucidly describes (and I am by no means confident that my own is the correct one), the facts themselves remain a perpetual source of wonder and delight to all who, like himself, not only possess a Microscope, but are able to use it.

II.—*A Further Inquiry into the Limits of Microscopic Vision and the delusive application of Fraunhöfer's Optical Law of Vision. No. II.*

By Dr. Royston-Pigott, M.A., F.R.S., &c.

(*Read* 13*th November*, 1878.)

Plate III.

The writer has been more particularly led into the present subject by the wide-spread belief that the limit of microscopic vision has been reached by the resolution of Nobert's lines drawn at the rate of 112,000 per inch, which probably gives the 1–200,000th for the diameter of the smallest line supposed to be visible. It will not be uninteresting to relate the history of this belief.

The celebrated Fraunhöfer (as stated in his Memoir to the Bavarian Academy of Sciences, June 14, 1823) succeeded in ruling lines as close as 30,000 to the Paris inch, which he found totally invisible with the Microscope. He also announced that if λ be the wave-length, and the light fell perpendicularly to the surface of the ruled glass, sine $\theta^{(\infty)}$ would become imaginary, and therefore the lines would produce no coloured spectra; and he concluded, says Sir John Herschel, "that an object of less linear magnitude than λ can in consequence never be discerned by Microscopes as consisting of parts." *

The skilful optician Nobert, believing in this result obtained by Fraunhöfer, utterly despaired that anyone would ever succeed in descrying his finest lines on glass.†

Now with regard to this very conclusion of Fraunhöfer, Sir John Herschel regards it as "one which would put a natural limit to the magnifying power of Microscopes, but "which," says he, "we cannot regard as following from the premises" (*sic*). ‡

Well, Dr. Woodward first achieved the honour of resolving these lines with a Powell and Lealand $\frac{1}{16}$ immersion in 1869; § and in consequence of the grave doubts expressed by their maker, he wrote to Dr. Barnard, a distinguished mathematician (Pres. Columbia College), who replied that "with an objective that takes

* Art. "Light," 'Encyc. Met.,' p. 490.

† Nobert thus wrote to Dr. Colonel Woodward, U.S., dated Barth, Feb. 26, 1869. He expressed his belief that the resolution of the higher bands is an impossibility when light is permitted to fall on closely ruled lines. "The formula," says he, "sin. $x = \frac{\lambda}{b}$ (Fraunhöfer's), if by λ we designate the length of the undulations, by b the distance between two lines of the grating, and by x the angle of the refracted rays, gives for sin. x an impossible value when b becomes less than λ;" that is to say, when the distance between two lines is less than a wave-length, the lines will become invisible.

‡ 'Encyc. Met.,' art. "Light," p. 490.

§ See 'Month. Mic. Jour.,' Dec. 1869, quoted by Dr. Woodward.

in a cone of an angle of from 140° to 175° it is nonsense to talk of this question as settled by theory. We shall continue to see closer lines just in proportion as Microscopes and modes of illumination are improved."*

That has long been the firm opinion of the writer. In the first paper on the subject of the limits of vision, he stated, "I believe this limit has not yet been reached;"† and farther on, p. 181, "With special adaptations to subdue or destroy the brilliant diffractions of too bright an illumination, many minute details before completely effaced may be brought into distinct revelation." When these remarks were made, the microscopical world had been recently favoured with the beautiful formula introduced independently, I believe, by Professors Helmholtz and Abbe, in which further elucidation of the principle was given by a new formula including the semi-angle of aperture of the objective used. Applying these similar results, I obtained, for mean rays of wave-length, $\frac{1}{46182}$ of an inch (46,000th nearly) the following results:—

A Table of Proportionate Resolving Powers‡ (some of the details of which were as follows):—

Full Aperture of Object-glass.	Proportionate Resolving Power.	Semi-aperture.
179°	sin. a = 99996 per inch	89½°
175°	sin. a = 99905 "	87½°
150°	sin. a = 96590 "	..
120°	sin. a = 86600 "	60°
12° 38′	sin. a = 11000 "	6° 19′

I hope to show in the following paper that however truly this optical law may be deduced from the premisses, it utterly fails for minute dark lines.

An announcement that it is possible to descry with microscopic apparatus the millionth of an inch would be almost too startling to believe. The human eye can distinguish a hair under favourable conditions of light and background subtending an angle of even less than a second. The black line dividing close double stars, such as X*ι* Ursæ Majoris, which are both of the same (fourth) magnitude, does not subtend in the telescope with a power of 300 diameters many seconds of arc. Besides this, the Microscope differs only from the telescope in the length of its focus and smaller aperture, which, according to received dogma, gives great advantages of vision to the instrument with so great an angular aperture. We cannot doubt, either, from the tales of travellers, that birds of prey possess exceedingly acute vision, by which they can descry small objects at a

* See 'Month. Mic. Jour.,' Dec. 1869, quoted by Dr. Woodward.
† P. 175, 'M. M. Jour.,' Oct. 1876. ‡ P. 181, ibid.

great distance. I myself knew a friend who could see with the naked eye Jupiter's satellites, and dot down their position though ignorant of astronomy. If a simple organ of sight can distinguish such objects as subtend only a second or two, it would seem strange that modern glasses can only show objects presenting many seconds to the eye at the last visual image formed in the eye-piece.

In the following observations I shall endeavour to substantiate a fact apparently irreconcilable with the results of the now famous formula.*

In point of fact, the opinion has now become established both in Europe and America, that Nobert's lines 112,000 per inch (or lines of that size) are the closest that can be seen; and that the law enunciated in the footnote forbids the hope of farther advance in minute definition.

Now, considering the readiness with which a fine horsehair can be distinguished against a light cloudy sky, as also spider lines at several feet distance, I determined to mount upon glass several spider threads and measure their diameter by means of Browning's spider-line recording micrometer. After many trials, I found the smallest of these measured 1–35000th in diameter (Fig. 4).

I measured them by means of Powell and Lealand's magnificent $\frac{1}{8}$ dry lens. On this spider thread I could perceive irregularities, nodules, and marks; but the general thickness was remarkably true. Some others measured $\frac{1}{16000}$, $\frac{1}{18000}$, and coarse agglomerations, cord-like, were as thick as fine spun glass $\frac{1}{3000}$th.

It then occurred to me to make a novel use of the "Aerial Micrometer" formerly described by me, consisting of the "Browning" inverted beneath the sub-stage, as also placed in a reversed position (see Fig. 3).

The law established contains two remarkable elements: the kind of light, i. e. the length of the wave, and the aperture of the objective. For blue light (wave $\lambda = 53000$ per inch) intermediate between blue and indigo, this, with an aperture of 150°, would give

$$\left.\begin{array}{c}\text{Extreme limit of}\\ \text{visibility}\end{array}\right\} \epsilon = \frac{\frac{1}{53000}}{2 \sin. 75^\circ} = \frac{1}{53000 \times 2 \times \cdot 960}, \text{ nearly} = \frac{1}{102000}.$$

* This is thus stated:—

If ϵ represent the smallest interspace recognizable between two bright lines or disks, on the condition that the diffraction fringe of one does not overlap that of its neighbour; and

If λ be the length of the wave of light under consideration, which for mean rays equals $\frac{1}{56183}$ of an inch; and

If a be the semi-aperture of the objective,

$$\epsilon = \frac{\lambda}{2 \sin. a} = \frac{\lambda}{2} \text{ (when aperture } = 180^\circ\text{)},$$

and

$$= \text{1–96590th (when aperture } = 150^\circ\text{)}.$$

So that with the more favourable blue ray the smallest interval visible among contiguous bright disks or lines is about one hundred thousandth of an inch, and that only with the largest aperture. Such is the belief disseminated.

About ten years ago I requested Messrs. Beck to make for me an "iris diaphragm" with "adapters" on each side. By this ingenious contrivance, screwed between an objective and the body, the angular aperture could be instantly reduced at will.

It seems, on the face of it, not a little surprising, considering this famous optical law, that the visibility of lines of great minuteness is very little affected by great reduction of objective aperture, by means of this instrument, or by using low-angled objectives of sufficient power and excellence of manufacture. Apparently this is another failure of the celebrated law, as roundly stated and generally received.

It will be convenient to explain here two practical points:—

A.—*The method used in finding the diameter of the spider lines enclosed within the micrometer.*

B.—*The method employed in measuring the absolute reduction of the object in miniature.*

A.—The Rev. Mr. Dallinger has given us his beautiful measurements of the flagella in monads, by drawing an equivalent line with a very hard fine pencil on white paper, by means of the *camera lucida*. By this process he, after a great many observations, determined its diameter to be less than the two hundred thousandth of an inch.

The plan I adopted was by finding divisions on glass placed in the focus of the eye-piece which appeared perfectly coincident in diameter with the observed spider line; and then substituting a scale of a hundred thousandth of a metre, a most careful measurement was made of the apparent size of the diamond cut. The process was much facilitated by altering the length of the draw tube, and changing the objective until the most acceptable result was arrived at. I am indebted to Mr. Beck for the use of an exquisite scale of this kind, as also for the loan of $\frac{1}{20}$th objectives, dry and immersion, which latter has reduced the miniature to the extraordinary minuteness and precision of definition, at seven inches, of one hundred and forty times less than the object.

On examining spider threads, gathered after recent spinning, with Powell and Lealand's best $\frac{1}{8}$ dry, and measuring them with the spider-line micrometer inserted in the body, I was charmed with perceiving the characteristic brilliant central band, due to a minute cylindrical lens of great beauty, and perfection of definition: and searching for threads lying flat and in close contact, I found some consisted of four cylinders in contact, showing four bright

bands running longitudinally. Taking a pair of these, the cross wires of the micrometer were accurately adjusted in the centre of each bright space, the result for this order of spider was (making the power 1000) with the micrometer

$$\frac{6\cdot7}{10000} = \frac{1}{15000}\text{th very nearly (see Fig. 1).}$$

Different spiders spin much thinner webs, and seem to unite several according to the tension required. Another fibre measured $\frac{1}{17000}$, and some are discoverable $\frac{1}{35000}$th. See Plate III.

B.—The reduction by miniature will be readily understood from diagrams, shown Fig. 3. There are two ways of deciding the ratio of reduction: the one by examining the size of the miniature itself, the other by finding the magnifying power of the apparatus used as a Microscope.

For this purpose it was especially mounted on the arm of the Microscope used to carry the body (exhibited to the meeting).

In these ways it was found that:—

Immersion	$\frac{1}{8}$ Powell and Lealand,	miniatured	36·7	times	at	$4\frac{1}{4}$	inches.
„	$\frac{1}{16}$ *b.* Gundlach.	„	50·17	„		$4\frac{1}{2}$	„
„	$\frac{1}{20}$ R. and J. Beck	„	140	„		7	„

The distance between object and spider lines in the focus of the positive eye-pieces varied accidentally with the length of the objective mount itself. But the "Beck glass" required seven inches to do it justice, and also to get the miniature sufficiently reduced. It was easy to form the image at any desirable distance, but then the mirror could not be used very well beyond seven inches, nor the micrometer held sufficiently steady without complex arrangements. The one shown is simple and adequate.

The miniature can, it is evident, be carried to any extent; which, however, is limited to certain dimensions depending upon two important conditions—brilliance or darkness. A very brilliant line or disk is enlarged considerably, whilst a dark line is little changed.

If you miniaturė the sun's disk by viewing an aerial image of it formed by a 3-inch lens (100″ distant), employing a magnificent $\frac{1}{10}$ immersion, you will get a disk reduced 1000 times theoretically; and since $\frac{1}{38\cdot2}$ of an inch is the diameter of the image of the sun formed by the 3-inch lens, its diameter miniatured on the stage is 1000 times less, or

$$\frac{1}{382000} = \frac{4}{100000}\text{* nearly.}$$

* See 'Proc. Roy. Soc.,' No. 146, p. 428.

But in the microscope it appears quite the ten thousandth of an inch, or nearly four times larger than it ought to be, if light had no undulatory waves. And this too, whilst using the most exquisite glasses obtainable. This tremendous fact shows how hopeless it is to expect brilliant disks to appear of the proper or natural size, if I may so speak, in the microscope.

In view of the extraordinary result of the measurement of solar spectra already alluded to, a very natural doubt will arise in the minds of those who have not had practice in this method of miniature, as to the correct effect of the glasses. Now the best process for solving the doubt is to watch the spider threads successively reduced from ten to fifty times. The operator will find it a slow process, as every possible adjustment of centricity and correction for aberration must be carefully attended to the whole time, as well as arranging the light. It cost me at first about six hours' work. But then the miniatures become so exquisitely smaller, the work in its very novelty becomes fascinating, and encourages one to persevere. The observer will have no chance of splendidly defining the millionth of an inch unless he is accustomed to high-power manipulation, and remembers that both upper and lower objectives must be both corrected by the screw collars for uncovered objects (dry or immersion), and change of distance of the focal images. Something too should be understood of the effect of change of "aperture" upon the appearance of a transparent cylinder of spider silk. It must be remembered that the aperture of the miniaturing objective, as this is used in an inverted position, is greatly reduced as regards the incident pencils emanating from the spider lines.

A pencil of rays proceeding from the cross or intersection of the spider lines about six inches from the back glass, enters it at an aperture of a few degrees only, perhaps ten. Now if a cylinder of glass or spider gum be viewed with a low-aperture objective (say $1\frac{1}{2}$), it will present two black borders, and the breadth of these borders narrows as the aperture is increased, and *vice versâ.* Also when the spider thread is diminished more and more, these black borders appear almost to coalesce until only a black line appears. The middle bright part vanishes with attenuation.

Then it may be further urged that a very fine glass forms miniatures of an object, theoretically, by merely optically reversing the rays as perfectly, indeed more so, than in the enlarged image of the same object. If therefore we can see the minute spider line very perfectly magnified one thousand times, we can, *a fortiori*, see the miniature, which is only fifty times smaller, with great precision. So much for the objection against the accuracy of miniatures formed by an excellently adjusted objective.

But *a crucial test is supplied by observing sets of cross wires separated a small space.* Fortunately I had requested Mr. Browning

to put a double set of cross wires, and also a set of parallel wires, in the micrometer. The head of the instrument is divided into one hundred parts, and a half or quarter part is readily seen with the naked eye. I may here observe, when the wires are reduced thirty-eight times by the $\frac{1}{4}$ (as one division of the micrometer is the $\frac{1}{10000}$ of an inch of motion in the wires), a single division for the miniature then reckons $\frac{1}{380000}$th. But I found a quarter of a division made a perceptible difference in the apparent thickness of two coincident webs; *whilst three whole divisions separated the webs* so completely, that a narrow strip of light could be discerned between them (not much room here for swelling or enlargement of the lines!).

I then changed the glasses, putting the best glass in the body, and the older one (both newly formulated) in the micrometer: the definition was not so good. It required $3\frac{1}{2}$ divisions to separate the same lines.

This dividing of close lines by means of a very finely constructed micrometer is quite satisfactory to my mind, and I should hope conclusive as a *crucial* test to others who may witness it that the lines are very truly portrayed.

The following little circumstance has an interest of its own. Having conveyed my instruments home from the London Museum, S.K., I found the webs entirely covered with London dust. Upon getting them, however, into rapid vibration, I succeeded in shaking off nearly the whole before measuring them. A few minute particles adhere here and there; and though these webs are diminished fifty times—i. e. to the 300,000th of an inch—these particles of dust are visible on the web in this state of reduction. This result is the most surprising of all.

It was found that under this reduction (fifty times) it required five divisions to separate the spider lines, or a movement of $\frac{5}{10000}$ of the micrometer, i. e.

$$\frac{5}{50 \times 10000} = \frac{5}{500000} = \frac{1}{100000}.$$

Each division represented here on the micrometer head

$$\frac{1}{500000} \text{ of an inch}$$

in the field of view of the Microscope.

It is interesting to inquire what effect separating the spider lines has upon the discriminating power of vision. The optical conditions of seeing a black line upon a white ground, and separating or clearly dividing between two close minute black lines, are totally different. The researches of Dr. Jurin, 150 years ago, and of Dr. Robinson, F.R.S., the astronomer, on the subject, are very interesting; but no observations have yet been made of the minute-

ness about to be related. The question arose, Is it possible to estimate a bright space between two spider lines when *total* separation is only the eight millionths of an inch, the lines themselves being the 8000th and the 7000th of an inch respectively, and reduced in the miniature thirty-eight times? Reducing the numbers to decimals, if S be the space reckoned between the centres of the spider lines, it is evident if t and t' be the spider lines in diameters, and x be the required interval (see Fig. 5),

$$x + \tfrac{1}{2}t + \tfrac{1}{2}t' = S;$$
$$\therefore \quad x = S - \tfrac{1}{2}t - \tfrac{1}{2}t' = S - (\tfrac{1}{2}t + \tfrac{1}{2}t').$$

The value of S was found by carefully measuring the movement of the micrometer $= \frac{3}{10000}$, which just brought the bright separating interval into view. Therefore we have the required size of interval (considering it diminished thirty-eight times),

$$\begin{aligned} x &= \frac{3}{38 \times 10000} - \frac{1}{2} \cdot \frac{1}{38.8000} - \frac{1}{2} \cdot \frac{1}{38.7000} \\ &= 0{\cdot}00000789 - 0{\cdot}00000164 - 0{\cdot}00000187 \\ &= \begin{array}{r} 0{\cdot}00000789 \\ -\ 0{\cdot}00000351 \\ \hline \end{array} \\ &= \quad {\cdot}00000438 \\ &= \frac{1}{230000} \text{ nearly,} \end{aligned}$$

or about half the interval between the centres of the wires.*

The astounding sight of wires or webs separated by an interval of light less than the two hundred thousandth of an inch can only be explained by the light being subdued. Indifferent glasses cause diffraction images, besides clouding over the view with residuary spherical aberration much more difficult of cure than the colour. Without this interval—I may say, this extraordinary interval—one might conclude the webs are in some mysterious manner enlarged in the miniature beyond the calculated value. And so they are in poor glasses; for the image appears blurred—swelled, as it were—or adumbrated. But now the lovely precision of definition witnessed in high-class glasses, not only of the webs, but of dust on them and specks on the lamp-glass, precludes any suspicion, in face of this interval, of the enlargement of the lines encroaching much upon its dimensions. Besides all this, as the webs pass and repass

* Putting the decimals into fractions,

$$S = \frac{1}{127000}; \quad \tfrac{1}{2}t = \frac{1}{610000}; \quad \tfrac{1}{2}t' = \frac{1}{532000}.$$

The above calculation, it must be remembered, refers to the effect of the micrometer screw diminished thirty-eight times by the Powell and Lealand $\frac{1}{8}$ best immersion.

each other, the smallest movement of the screw changes their apparent thickness before division or separation is seen.

The miniatures were measured as follows:—

At Distance. Inches.			Miniature reduced. Times.
6¼	.. ..	Very old ⅛ Powell and Lealand	49
6¼	.. ..	1862 ⅛ Powell and Lealand (immersion) ..	58
6¼	.. ..	1875 ⅛ " " " ..	55
7	.. ..	1878 $\frac{1}{50}$ R. and J. Beck (immersion) ..	140
7	.. ..	1878 $\frac{1}{50}$ Beck (dry)	118·6
6½	.. ..	1873 $\frac{1}{15}$ Gundlach (immersion)	91·3
5½	.. ..	1877 ⅛ Zeiss (oil immersion)	49
6½	.. ..	1863 1-inch Powell and Lealand	6·07
6¼	.. ..	1851 ¼ Andrew Ross	27·6
6	.. ..	1870 ½ Wray	13·4
6	.. ..	1870 ¼ "	29·5

To accurately adjust the observing and miniaturing objectives in the same optical axis is easily done with low powers. If both are equal in power, the test of the quality is very severe, as I have shown elsewhere.* With a then excellent Powell and Lealand ⅛ made for me in 1862, and improved by them after its return to the makers, a fog is still seen when observed by their brilliant newly-formulated ⅛ immersion. But still the spider lines are visible. It is not till objectives of equal and I may say of surpassing beauty of definition are opposed to one another above and below, nose to nose, that their exquisite powers of displaying fine black details are exhibited.

The Gundlach immersion is of very fine quality. On reference to the table, it diminished the spider lines 91·3 times when the distance between them and the miniature was 6½ inches. This gave for the first and second lines ($\frac{1}{8000}$ and $\frac{1}{7000}$th diameter respectively) miniature sizes of

1st web .. .. $\frac{1}{730000}$ of an inch.

2nd web .. .. $\frac{1}{640000}$ "

The sizes of the web No. 1 with the different objectives may thus be tabulated:—

Dist.	Inches focus. 1	¼ Ross	⅛ Powell	⅛ Powell and Lealand	$\frac{1}{50}$ Beck
6½	$\frac{1}{48000}$	$\frac{1}{220000}$	$\frac{1}{300000}$	$\frac{1}{460000}$	$\frac{1}{1120000}$

These were mostly at 6½ or 6¼ inches. At a greater distance —10 inches—the diameters of the spider line of $\frac{1}{8000}$ with the two latter glasses would be,

⅛ Powell and Lealand	$\frac{1}{50}$ Beck
$\frac{1}{640000}$	$\frac{1}{1600000}$

* 'Phil. Transact.,' vol. ii., 1871.

These astonishing results, so contrary to what had been generally supposed, demand thorough investigation. And with a view to elucidate this unusually important subject, it will be interesting to inquire what is the visual angle of fine-line objects just visible by different observers.

	Diameter of Hair.	Distance visible.	Angle.
		feet.	seconds.
Mr. Broun, F.R.S., 'Proc. Roy. Soc.' ..	·0026	36	$1\frac{1}{4}$
Mr. Slack, P.R.M.S.	·003	$45\frac{1}{2}$	1
With sun illumination and grey sky background	·003	76	6-10ths
Against white wall of house, sun still shining	·003	113	4-10ths
Lit up by sun glittering	·003	173*	..

It is now requisite to determine what would be the visual angle of the spider line $\frac{1}{8000}$ of an inch miniatured 140 times smaller with the Beck $\frac{1}{20}$, and then magnified up 1000 times by an eighth immersion with C eye-piece and about 10 inches of tube. Here

$$\text{Visual diameter of web } \delta = \frac{1}{8000} \div 140 \times 1000 \text{ at a distance of 10 inches.}$$

Hence

$$\sin.\ \theta = \frac{\text{Perp.}}{\text{Radius}} = \frac{\delta}{10} = \frac{1000}{140 \times 8000 \times 10} = \frac{1}{11200} = 18 \text{ seconds nearly.}$$

The most ready way of getting the value of the fraction in seconds is by recollecting that $60'' = \frac{1}{3438}$ nearly.

Referring now to the former table, it will be found by simple arithmetic that since the Beck $\frac{1}{20}$ immersion shows theoretically a visual angle of 18 seconds, miniaturing 140 times, a glass reducing only fifty-eight times ought to show at an angle of $7\frac{1}{2}$ seconds at a power of 1000, and at a power of 500 at about 4 seconds. I see the line plainly, most charmingly defined with 500, and can even see them when miniatured only thirty times. A good deal might be written on this extraordinary fact. As the aperture of the objectives is diminished the spider lines look blacker, and therefore *larger*. I reserve this question for future treatment.

In inferior glasses the spider lines are thickened, and, besides this, garnished with secondary lines, true diffraction lines, and this you may see. I first detailed the method of miniatures in the 'Philosophical Transactions' eight years ago; but I have had nearly twelve years' experience of this method, and I have several times recommended it to the microscopical world with great cor-

* The glittering line here would afford a broad spurious line greatly enlarged.

diality. It is superior to all others for detecting residuary errors, and when these are nearly compensated the miniatures of spider lines of any size are portrayed with enchanting precision.

To sum up:—The whole question of minute vision is the least visual angle first of naked vision, and secondly in instrumental vision.

It can hardly be expected that any Microscope, especially if connected with miniature apparatus, involving the total use of some twenty lenses arranged as nearly as possible with one continuous optical axis,—that any Microscope, I say, can ever equal the simplicity of human vision. But then, with the unassisted sight we can easily determine the limits of vision by receding from the object, and so making the visual angle smaller and smaller until the hair vanishes. This we may call the vanishing angle θ.

Now the art, if I may so speak, of making very minute objects visible, may be applied by my method to render them distinctly visible as they get smaller and smaller as miniatures, and at last reach the vanishing limit.

But to my eye, which is, I must confess, the worse for these experiments, lines can be formed under the Microscope which also by lowering the ocular power, or diminishing the miniature, resemble (I will not say absolutely identify themselves with) the vanishing phenomena of naked vision.

When I see spider lines sharply defined become beautifully less, and give one the same appearance as a hair upon a window-pane, vanishing as its visual angle reaches the limit, I am bound to believe, nay be assured, though against all modern belief and theory apparently, that I do see these exquisitely small lines just on the point of evanishment at a very small visual angle indeed. Anyone with ordinary sight can see a human hair on a window-pane against a moderately white sky at a distance of two feet and a quarter. This is an angle of 20 seconds.

At five feet it is	Nine seconds.
„ ten feet it is	Four and a half seconds.
„ twenty feet it is	Two and a quarter seconds.

Now, on comparison of the minute lines exhibited by me microscopically, the hair lines appear equally small in each mode, either by viewing them on a window-pane at a yard off, or in the microscope diminished fifty times, and then sufficiently enlarged. The irresistible conclusion from this comparison is that the eye can discover a minute hair line either on the window-pane or in the apparatus exhibited, at certainly a smaller angle than 20 seconds. In other words, the minute microscopic image appears as small as a hair several feet off, according to the acuteness of vision.

The highest experimental proof by comparison is thus strongly in favour of a line sharply and clearly defined, subtending an

angle of 20 seconds, and probably a good deal less, as 2 seconds is the visual limit that can be seen in the apparatus or by the eye alone.

Another very curious point is worth mentioning. Dr. Jurin 150 years ago stuck two pins on a window-pane, and found that when placed near each other he could not divide them except when the interval between them reached the wide visual angle of 30″. But when only one pin was viewed, he could distinguish it at a visual angle of from 2 to 3 seconds!

This interesting fact explains what I have witnessed in separating the spider lines of the micrometer in these miniatures: the interval could only be seen when the lines were separated, centre to centre, three divisions (micrometer), each division representing $\frac{1}{400000}$ when a minuendo of *fifty times* was employed; yet one can see a most sensible thickening of the gossamers just beginning to separate by moving the micrometer half a division. From this, I presume, a similar phenomenon was produced, though very much less pronounced than Jurin's case. It is marvellous to me that a visible bright space between these lines can be seen at all when their centres are separated only three divisions, i. e. $\frac{3}{1000000}$ or $\frac{1}{300000}$ of an inch. Considering that there must be some residuary aberration, however small, and that the error of each set of glasses accumulates in the final image presented to the eye, it seems to me wonderful that, notwithstanding Jurin's fact, a division is visible between the gossamers at all with so light a movement as described.

In continuation of this subject, I propose to offer to the Society some researches on the effect of large and small apertures in object-glasses. I beg to commend this research to the earnest attention of the rising generation of microscopists. Unless I am very much mistaken, the idea propagated in reference to the limits of microscopic vision is totally erroneous; whilst for brilliant lines or minute disks of great brilliance, I have not the slightest hesitation in embracing the truths conveyed in the exquisite formula presented to the microscopical world by, I believe, independently, Professors Helmholtz and Abbe.

It is almost needless to remark that very firm supports and delicacy of the adjustments as regards spherical aberration and illumination are essential to the success of this refined kind of definition.

III.—*On some Recent Forms of Camera Lucida.*

By Frank Crisp, LL.B., B.A., Sec. R.M.S., &c.

(*Read* 11*th December*, 1878.)

During the present year four or five forms of camera lucida have been brought forward, all claiming to be original, and to enable the observer to see more readily the image of the object and the point of the pencil at the same time, and I have thought it might be in some degree desirable to notice them—as a matter of history, at any rate.

(1) The first is that of Dr. Hofmann, the well-known optician, of Paris.

Fig. 1 shows the camera, properly so called, and Fig. 2 its transverse section.

The rays coming from the object, and passing through the lens C, meet the plate of silvered glass A, by which they are reflected to the transparent glass plate B, and thence to the eye through the

Fig. 3

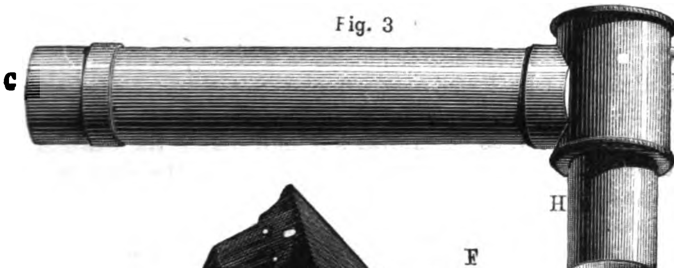


Fig. 1

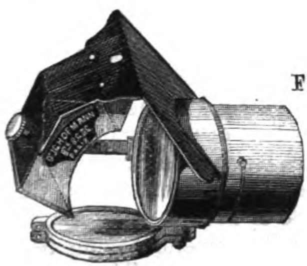


Fig. 2

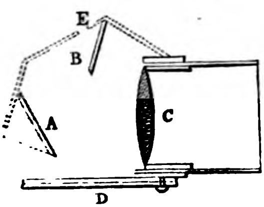


Fig. 4.

aperture at E. At D are two lenses of different foci, which can be interposed between the eye and the paper, as with the ordinary Wollaston form.

With a vertical Microscope the additional piece of apparatus

(Fig. 3), containing a reflector at N, is employed, the camera fitting over it at G, and the whole being inserted into the tube of the Microscope by the part H.

The instrument is thus suitable for powers up to 500; beyond this limit, however, it is desirable to substitute for the colourless glass plate B a tinted one.

The camera, to use Dr. Hofmann's expression, "suppresses all existing eye-pieces," but with objects requiring only small magnification to be within the field of the camera the arrangement is employed which is shown in Fig. 4. It consists of two plano-convex lenses of different foci, and slides into H.

The part No. 2 may be used alone, No. 3 being taken away. If the image of the object is still beyond the field of the instrument, the lens in No. 2 is unscrewed, and No. 3 replaced, which gives a second amplification; and with both lenses in their place a third is obtained.

Dr. Hofmann writes that this apparatus is the result of an expenditure of no little time and thought on his part, and that it has been very highly commended by leading men on the Continent.

(2) A second form also originates in France, and is the invention of M. Pellerin, who describes its principle in the 'Comptes Rendus' * of the French Academy.

With the view, as he expresses it, of avoiding the weakening of one of the images through reflection by a transparent plate as in some forms, and the irksomeness of others which require that the object and the drawing should each be viewed with half the pupil, he suggests the following arrangement, which is an imitation of M. Cornu's polarizer, and gives two images of the same intensity and visible at the same time by the whole of the pupil.

A Wollaston camera lucida being made of glass having an index higher than the extraordinary index of spar, there are joined to the face which has an angle of 135° a plate of spar and a prism made of the same material as the camera, having its second face parallel to the face whence the rays emerge. Thus, at a suitable inclination, one-half the light coming from the object will be totally reflected as extraordinary rays, and a part of the light coming from the drawing will be transmitted as ordinary rays. The portions reflected and transmitted will be each one-half if there is no reflection of the ordinary rays, the condition for which is, that the glass of the two prisms and the cement which unites the pieces shall have the ordinary index, and in practice this can always be approximately attained.

For these assumed conditions, and the plate of spar being perpendicular to its axis, the following calculation is given of the field, which is then equal in all directions: in the interior of the glass

* Vol. lxxxvi. p. 764.

the extreme rays make an angle x the complement of the limiting angle,

$$\cos. x = \frac{n_e}{n_o}, \qquad x = 26^\circ;$$

but that the faces of entrance and emergence may be cut perpendicularly to the mean direction of the rays, the angle of refraction of the extreme rays is $\frac{x}{2}$ and the angle of incidence y, so that

$$\sin. y = n_o \sin. \frac{x}{2},$$

$$\sin. y = \sqrt{\frac{n_o (n_o - n_e)}{2}},$$

$$y = 22^\circ.$$

The field (maximum in these conditions) is 44°; the instrument will take this in completely without rotation if the face attached to the spar is the third of the other, the aperture for the eye being near its edge. The angle adjacent to the spar is 90° — 13° = 77°.

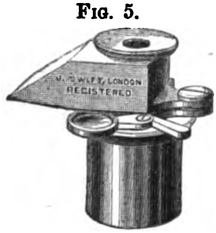
To regulate the intensity of the two images, a polarizer may be interposed in the path of the most luminous rays, such an apparatus, for example, as M. Cornu's made of the materials above mentioned.

No drawing accompanies M. Pellerin's paper. He adds that a camera lucida of the same description may be made for vertical Microscopes by replacing the quadrangular prism by a parallelopiped with an angle of 77°.

(3) The third arrangement is that of Mr. James Swift, shown in Fig. 5, and can be used at any inclination of the Microscope.

The principle of the instrument, as described by Mr. Swift, is that the image of the pencil and paper is received by a prism (enclosed in the box which projects on the left-hand side of the figure), by which it is reflected to a piece of neutral-tint glass placed at an angle of 45° over the centre of the upper lens of the eye-piece. The neutral-tint glass allows the image of the object in the Microscope to be distinctly seen, while that of the pencil and paper is at the same time visible on its first surface; no second image occurs by reflection from the back surface, owing to the tint of the glass.

Fig. 5.



A second disk of neutral-tint glass can be interposed when the light requires to be subdued to show the point of the pencil distinctly. It will be seen that in principle the instrument is an adaptation of Nachet's well-known form.

(4) The fourth form is that of Dr. Russell, which will be

exhibited by Dr. Millar this evening, and forms the subject of a separate paper.

(5) Although not a "form of camera lucida," yet it will not be out of place while dealing with this subject to call attention to a modification of a method of drawing objects under the Microscope originally described in 'Hardwicke's Science-Gossip' for 1867 (p. 236.) The method there suggested was to throw the image formed by the object-glass on to a sheet of paper fixed over a piece of common window-glass at one end of a "camera obscura," the Microscope being placed at the other end, and the eye-piece removed. Mr. H. E. Forrest, of Birmingham, now suggests that a rectangular prism should be placed over the eye-piece of a horizontal Microscope, thus throwing the image of the strongly illuminated object on to the paper on the table, the room being darkened. This method, while obviously requiring powerful illumination for high powers, is said to "enable even diatoms to be drawn with a $\frac{1}{8}$ objective."

I have purposely abstained from any criticism on the various methods above described, preferring to confine myself to a simple record of the fact of their invention.

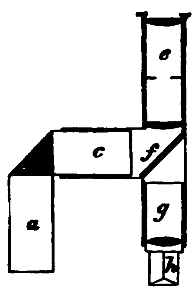
IV.—*Description of a New Form of Camera Lucida.*

By J. Cunningham Russell, M.D., Lancaster.

(*Read* 11*th December*, 1878.)

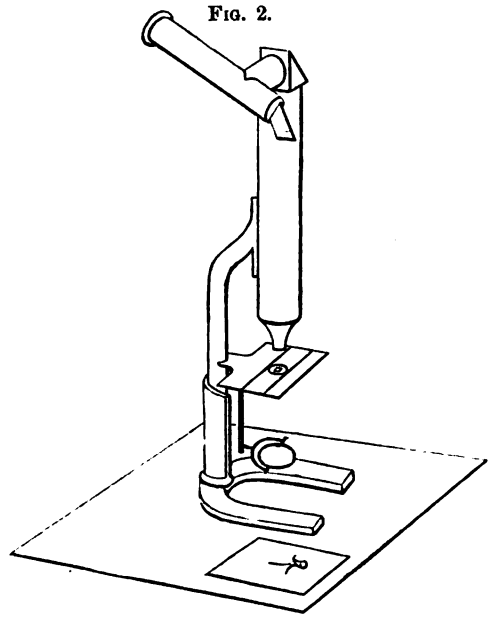
The principle of this instrument is that, in place of the paper or its reflection being viewed by the eye directly as in the cameras hitherto constructed, there is formed, by means of a lens acting as the object-glass of a telescope, a real image of the paper at the same point as the image of the object formed by the microscopic objective, and these two images forming one combined image are viewed through the eye-glass of the Microscope. The advantages of this construction are that the images being as one it is impossible that the image of the object should shift even in the least degree upon that of the paper, and that the images being at exactly the same distance from the eye, they are both in focus at once, and there is no straining of the eye to accommodate it to both object and paper, as is apt to occur with other instruments. It also avoids the necessity of looking through a small aperture, the ordinary eye-

Fig. 1.



a, Tube fitting into the Microscope.
b, Rectangular reflecting prism.
c, Horizontal tubes.
d, Vertical tube (inclined when in use), containing
e, Eye-piece.
f, Plane reflector of tinted glass, and
g, Telescopic object-glass.
h, Erecting prism attached to the last.

Fig. 2.



piece being used; and it admits of a convenient inclination being given to the eye-piece while the body of the Microscope is upright.

The construction of this instrument is shown in the accompanying figures and is as follows:—A tube fits into the tube of

the Microscope: at the top of it there is a right-angled prism (in a box) which reflects the rays along a horizontal tube of convenient length; this is crossed at the end by a vertical tube, and at the intersection there is a piece of tinted glass which reflects the rays up the vertical tube. In the upper limb of the vertical tube is inserted the eye-piece, and in the lower limb the convex glass which acts as the telescopic object-glass, and the rays from which passing through the tinted glass form an image of the paper in the focus of the eye-piece. As this image is inverted, and it is necessary for easy drawing that it should be erect, an erecting prism is attached below the convex glass. In use the tube, which I have for simplicity called the vertical tube, is inclined, by a motion round the axis of the horizontal tube, to an angle of about 60° from the vertical, so that the lower face of the erecting prism becomes nearly horizontal, the paper is put on the table below it and focussed by sliding the object-glass in or out. The light on the object must of course be suitably modified so that the paper and pencil may be distinctly seen.

I do not put forward this model as the best possible form in which the principle may be applied; I have no doubt it is susceptible of many improvements, but the principle itself is, I believe, a sound one. It is equally applicable with the necessary modifications to drawing objects in the field of a telescope.

Lenses may be used to erect the image instead of a prism.

V.—*Immersion Illuminators.* By J. Mayall, jun., F.R.M.S.

(*Read 8th January*, 1879.)

The need of special apparatus for illuminating objects mounted in balsam, or other refractive medium, seems to have been clearly in Mr. Wenham's mind when he contributed his paper on "Illuminating Opaque Objects" to the 'Transactions' of the Society in 1856. The appliances then described were, a right-angled prism, a truncated hemispherical lens, used with his paraboloid, and the "paraboloid of solid glass with a flat top." These were, strictly speaking, *immersion illuminators:* the last is the original "immersion paraboloid." It was shown by diagrams that the illuminating rays were made to impinge on the upper internal surface of the cover-glass at an inclination beyond the "critical angle" (or flat-plate limit between glass and air), and reflected by *total reflexion* upon the object, which is then seen in a dark field.

The reflex illuminator designed by the same inventor, sixteen years later, was based on the same principle.

With these appliances, used according to the principle of construction, *dark-ground illumination* is produced with dry objectives, whether the illuminating rays are internally reflected from the cover-glass on to the balsamed object, or the object is capable of deflecting the *direct* rays from the illuminator so as to become self-luminous and visible by means of what may be termed *scattered* rays.

It has been generally held that, as stated by Mr. Charles Brooke, "the more minute structure of some objects is cognizable *only* by its influence on rays traversing the object at considerable obliquity." To this end many appliances have been designed to be used with dry objectives. In Amici's prism, Nachet's prism, the truncated paraboloids, right-angled prism, truncated hemispherical lens, Reade's dark-ground illumination, the "kettle-drum" diatom-prism, the reflex illuminator, and others too numerous to mention, we have either the use of an actual stop to block out portions of the rays, or the illuminator is placed in such a position as to provide light in particular directions. The main purpose in all is to utilize the more obliquely incident light to the exclusion of the central.

On the importance of regulating the obliquity of the illumination on the object in its relation to the apertures of dry objectives, I quote from Mr. Wenham's paper "On the Illumination of Objects . . ."*:—

"Practically it is found that there is a precise but different angle of illumination required for every aperture of the object-glass, in order to give the maximum of distinctness; or that will even at

* 'Quart. Journ.,' 1854, vol. ii. p. 152.

all develop the markings on difficult tests. For if we continue to increase the angle of the mirror [he refers to diagram] the object first acquires a pearly appearance, and is afterwards seen in a dark field known as 'Reade's back-ground [black-ground?] illumination' . . . . but the markings have again become indistinct or disappear altogether, showing that it is needful to allow a small portion of the light from the source of illumination to pass into the object-glass, and through the object, that the striæ may either be rendered more visible by the rays that they intercept, or that the field shall be partly luminous."

Within the last few years the apertures of objectives have been so considerably extended by means of the immersion system, that, in order to utilize their fullest power, it has been found necessary to use an immersion system of illumination. By these means we obtain *direct* rays (i. e. rays other than those merely deflected by the object) from the illuminator at greater inclination than the critical angle, which certain of these immersions will transmit, producing a luminous field.

When the object is in balsam, and the base of the slide plane and in air, no rays can reach it from beneath at an obliquity greater than the limiting angle for balsam. In order that *direct* rays may *enter* the balsam beyond the inclination of 41°, we must have recourse to an immersion condenser, or something equivalent.

But it must not be supposed that the limiting angle at which rays could be admitted into balsam from beneath, through a flat plate of glass, imposes the same limit to the angle up to which an immersion objective could collect image-forming rays, supposing them to have got into the balsam,—which assumes that the image-rays above the object are limited by the angle of the *direct* illuminating rays from beneath. This erroneous view has had some currency, and may be thus stated:—*Because* the object in balsam cannot receive light from beneath beyond the limiting angle for balsam, unless we have an immersion system of illumination (supposing the base of the slide plane and in air), *therefore* there are no rays from the object beyond that limit to be transmitted by the immersion objective, however great its aperture; the question arising—"Where can such rays come from?"

It is evident that, independently of the angular direction of the illuminating rays, if there be an object in the field capable of *scattering* (and not merely intercepting) light, it is seen luminous by *scattered* rays. Regarded then as a *self-luminous* object, rays are nascent therefrom and scattered equally in all directions, and therefore at greater inclination than 41°. There is no theoretical difficulty in their reaching the second surface of the front lens of an immersion of suitable form, and in their being transmitted. They cannot, however, take part in the formation of the image by

a dry objective, because they are *internally* reflected by the cover-glass. These rays must be regarded as important for delicate markings, as evidenced by comparing the definition we obtain with the highest-angled immersions and dry objectives on a balsamed object with ordinary illumination,—that is to say, when the base of the slide is plane and in air.

The utilization of the whole of the very large cone of rays that might be condensed on the object by using an immersion illuminator having an aperture equal to that of the objective, in other words, the *direct* illumination of the whole aperture, is not the problem that has engaged the attention of those who have endeavoured to exhibit the fullest power of the apertures of immersions. It was long ago found that it is not so much mere *quantity* of light that is required on the object, as difference of illumination that can be rendered perceptible by the eye. The more difficult images are seen only as we utilize the extreme marginal aperture of the objective and the more oblique direction of the illuminating pencil. This can only be done practically by excluding all excess of central light. The objects on which the fullest power of the aperture is needed are generally so nearly of the same refractive index as the fluid in which they are immersed, that there is difficulty in making delicate differences of transparency perceptible. The immersion system of illumination becomes all-important to this end, as, by it, any required degree of intensity of light can be got upon the immersed object at the most favourable obliquity for the aperture of the objective.

It is found in practice that to obtain the fullest effect on the object, of the *extra*-oblique rays provided by immersion illumination, the objective must have an aperture capable of transmitting them, so that the field is luminous; they thus become a practical proof of the extent of the aperture. It follows also, as matter of observation, that up to the angle to which the objective refracts the *direct* rays from the illuminator to a luminous field, to that angle (or very nearly so) it refracts image-rays from the object; for we find that increasing the obliquity of the *direct* illuminating rays so as to approach to the dark-field produces, at the same time, distortion of the image,—showing that both systems of rays traverse the objective together.

The angle of the *direct* illuminating rays must not, however, be regarded as an essential condition of the *existence* of the aperture (as such). It proves the extent of the aperture of the objective by direct transmission; its effect in rendering visible minute structure is plainly matter of experience,—and experience shows that, so far as apertures have been carried, the gain has been in proportion to their capacity for *direct* transmission.

It will be understood that I refer only to objectives in which the corrections have been made to the fullest extent of the aperture; for it must be agreed that there is no such thing as *aperture*,

properly speaking, unless the image of a point be rendered as, approximately at least, a point.

Now, although, as I have shown above, Mr. Wenham understood the need of special means for illuminating obliquely objects in balsam, and the importance of the angle of illumination in relation to the aperture of the dry objective, I do not think he can be credited with having understood (much less foreseen) the important part the immersion illumination of balsamed objects would take in the development of the fullest power of immersion apertures. Indeed, as he has contended that the 82° *limit* of dry objectives obtains equally in immersions, he must be held to deny the existence of any aperture beyond 82°: consequently, the application of the immersion illuminators above mentioned, for *directly* utilizing any such aperture, must be regarded as a discovery quite apart from his original application of them for dark-ground illumination.

It appears to me that to Mr. Tolles is due the merit of first applying immersion illuminators to balsamed objects in connection with immersion objectives for the distinct purpose of utilizing by *direct* transmission the excess of "interior angle" beyond 82°. He was the first to produce objectives having interior angle considerably beyond 82°, and to demonstrate their advantages. With these objectives a luminous field was obtained when the whole of the illuminating rays that can enter into a dry objective were blocked out, and none but rays beyond this limit admitted: thus exhibiting at once a luminous field and a definition of immersed objects by means of the *extra* aperture that had not been seen before. He appears to have experimented chiefly with the semi-cylinder, because of the facility it offered for immediately obtaining a reading of the precise degree of inclination the illuminating rays made with the axis, so as to determine the actual limit of the apertures of the objectives he had devised; the display of difficult test-objects being merely incidental to his efforts to improve the instrument.

Dr. Woodward has given special prominence to the principle of the immersion illumination, in its immediate connection with the development of the power of aperture, by his "simple device," in which he originally provided means to exclude all rays of less inclination in glass than 45° from the axis, so that no objective having "interior angle" less than 90° would give a luminous field with it: it thus affords a proof of his position in the aperture question. Viewing it as an illuminator only, Dr. Woodward has simplified the mode of mounting the prism, and slightly varied the angle in a second prism: his last paper referred to these changes. I was also led to design a modification of this device, which is, briefly, to utilize the four exposed surfaces of the prism by cutting them at different angles so as to approximate nearly to the semi-aperture of the objectives likely to be used. This purpose is attained with a

success approaching perfection in Tolles's "traverse-lens," which I hope to place before you shortly with the inventor's notes.

Many experimental devices have been made for the same purpose. At the last meeting I exhibited another modification I had had made of Dr. Woodward's "simple device"; also a nearly hemispherical lens and a small semi-cylinder conveniently adapted for use on the sub-stage.

I mention Hyde's oblique illuminator for its novelty in combining a condenser with prism-illumination. It is a right-angled prism with a lens of short focus cemented on the long face, and will give a beam of condensed light up to a high degree of obliquity. Captain Tupman brought it from America four years ago. I am not aware whether the inventor designed this for the purpose of utilizing by *direct* transmission the *extra*-oblique rays that can be utilized only by immersions having "interior angle" beyond 82°, or he intended such rays to produce dark-ground illumination only. The plan is ingenious. I have, however, found by cementing a small lens on one of the exposed faces of Dr. Woodward's prism the same results are obtained more conveniently.

I refer also to a plan of illumination which Captain Tupman informs me is due to Mr. Tolles. It consists of placing a suitable prism in immersion-contact, on the surface of the balsamed slide, so that rays from a bull's-eye lens may pass directly to the internal surface of the base of the slide at an inclination beyond the critical angle, they are then *totally* reflected to the object. This requires some care in the manipulation.

Professor Abbe has adopted the use of a small lens * placed in immersion-contact with the base of the slide; which is a very simple and effective plan, and has been known for some years past. It is really so practical as almost to supersede the more elaborate contrivances for use beneath the stage.

Lastly, I refer to a reflecting immersion illuminator which I have suggested to Professor Abbe, and which he has undertaken to have made for me by Mr. Zeiss: this will be placed before you when completed.

Immersion illuminators are designed to secure a particular angular direction to the illuminating rays while actually in the body of the fluid in which the object is immersed, with a view to utilizing incident light of great obliquity; used in connection with the highest-angled immersion objectives, they have given fair grounds to expect that the future of the most difficult investigations in microscopy will be largely dependent on their successful application.

* At the Meeting in June I erroneously stated that Mr. Wenham had used a similar lens for the same purpose many years ago. He used the lens for reflex illumination from the cover-glass—*not* for *direct* illumination.

VI.—*Note on a Revolver Immersion Prism for Sub-stage Illumination.*

By James Edmunds, M.D., M.R.C.P. Lond., F.R.M.S., &c.

(*Read 8th January*, 1879.)

The value of a right-angled immersion prism as a sub-stage appliance for the illumination of objects under the Microscope was shown by Mr. Wenham in the year 1856, in a paper * published in the 'Transactions of the Royal Microscopical Society.' Mr. Wenham's paper is illustrated with a woodcut showing a right-angled prism attached to the under surface of a slide by means of oil of cloves, balsam, turpentine, or camphine; light concentrated by a bull's-eye being deflected upwards by means of an Amici prism. In the same paper Mr. Wenham also shows how, by means of a hemispherical lens, or "a small paraboloid of glass with a flat top" similarly attached to the under surface of the slide, other methods of immersion illumination may be made effective and, as he says, "show the Diatomaceæ with a degree of beauty and delicacy that he had never seen equalled."

The Tolles Microscopes have now for some years had fitted to their stages deep spherical and cylindrical lenses to be used for immersion illumination, and the splendid oil lenses now made by Zeiss are sent out accompanied by a small lens to be attached to the under surface of the slide with cedar oil, in order to supply light on the same principle. Colonel Woodward also has recently favoured this Society with two papers developing this most valuable method of illumination for high-angled lenses, and he has combined with the right-angled immersion prism two screens of thin metal perforated in line with the object, so that entering light may, when necessary, be demonstrably limited to parallel rays at a determinate angle.

The oil of cloves, used as an intermedium by Mr. Wenham, has been adopted by Colonel Woodward. Cedar oil, castor oil, or pure glycerine (Price's) also answer perfectly. As to the light, it will be found that a 1½-inch achromatic objective serves much better as a condenser than a bull's-eye, and that an image of the edge of a paraffin-lamp flame should be accurately condensed upon the object.

I now have the honour to submit a new combination prism, con-

* "On a Method of Illuminating Objects under the Highest Powers of the Microscope." By F. H. Wenham, Esq. Read March 25, 1856. 'Transactions of the Royal Microscopical Society,' vol. iv. pp. 55–60.

structed for me by Messrs. Powell and Lealand,* which will, I think, be found to render immersion illumination more manageable and more generally useful. I have termed it the revolver prism, because, by its means, unrefracted light at four grades of obliquity may be successively thrown into the object simply by rotating the prism and altering the inclination of the Microscope. This prism is of hard white crown glass, and six or seven eighths of an inch in diameter. Above, it has a circular plane surface, with a border curving downwards so as to afford hold for a setting which does not rise high enough to touch the slide. Below, it has four facets produced by grinding down a spherical surface into two right-angled prisms, whose lower edges are located at right angles to each other, and whose faces respectively make with the top surface angles of 30° and 60°, 41° and 49°. These four facets, taken consecutively, are normal to light entering at 30°, 41°, 60° and 49° of obliquity to the optic axis. The prism is sprung into the top of a vertical tube deeply slotted for the passage of light to the various facets, each slot being cut down to a line at which the side of the tube would be intersected by the plane of the facet on the opposite side. Below, the tube screws or slides into an adapter, or expands into a ring for the sub-stage. The top surface of the prism connects to the slide by means of a minim of cedar oil or Price's glycerine, and glare is prevented by the fact that superfluous light is reflected out through the slot behind. Each slot is figured with the obliquity of the light for which it is cut, and by a simple addition the entering light may be demonstrably limited to a particular angle, as with Dr. Woodward's perforated screens.

By means of this immersion prism the obliquity of the illumination may be so graduated as to shut out the light field and the ordinary negative image in so far as is necessary to obtain the diffraction image at its best point. With light at 60° from the optic axis the diffraction image is so far isolated that *Amphipleura pellucida* in balsam may be seen upon a dark background with the new oil lens. With light at 49° or 41° the field becomes lighted in proportion to the angular aperture of the objective, and the diatom is finely displayed, but with light at 30° the lines disappear.

Amphipleura pellucida in air, whether upon cover or slide, may also be shown by this prism. If the diatom be upon the slide, an intense black-ground illumination may be produced through the higher-angled facets, and the lines are shown as green and black bands, as they are by means of the immersion paraboloid.† If the diatom be upon the cover, the two lower-angled facets will show it,

* I exhibited this prism on June 5, 1878, at the soirée of the Metropolitan Branch of the British Medical Association.

† "On the Paraboloid Illuminator.' Vide 'Monthly Microscopical Journal,' August, 1877, p. 81.

but for full illumination the facet at 30° is required. Light emerging from the slide at 30° is, of course, bent down so as to strike the under surface of the cover at about 49°, and in this light the dry diatom may be splendidly resolved. In balsam, light at about the same angle (49°) seems to resolve the diatom best. With *Amphipleura pellucida* the light should in all cases strike the diatom *end on*, or it will not be resolvable. The brilliancy of the field also must be kept in due subordination to the influence of the diffraction image, and as the following method of procedure makes this very difficult object quite easy, I may perhaps be permitted to describe it.

1. By means of a four-tenths objective, a diatom should be selected, centred, and turned so as to lie exactly north and south in the field.

2. If light at 49° is needed, the corresponding facet of the prism should be turned to the front. The Microscope tube should be inclined through the complementary angle (41°), so that the facet stands vertical.

3. The lamp flame—edge on—should be set on a level with the object, and at eight inches distance.

4. A 1½-inch achromatic objective should be arranged in line, so as to condense upon the object a fine image of the lamp flame. In order to show that the image of the flame is accurately focussed upon the object, a piece of wet tissue-paper may be laid upon the top of the slide, or the image of the flame upon the face of the observing lens may be viewed through a side facet.

Under these circumstances the lines will be perfectly resolved if the lens have an adequate angular aperture and be properly adjusted. The method is very simple, but for want of it I have seen an experienced manipulator spend hours in "fiddling about for the lines," and utterly exhaust his eyes without determining whether or not the optical capacity of the lens on trial was at fault. By the method I have described, this difficult object may be resolved as easily as a Podura scale. If, when the lines are properly resolved, the eye-piece be taken out, there will be seen, on looking down the tube, at the southern edge of the field, a small clear image of the flame, and at the northern edge—diametrically opposite—a soft, greenish-blue diffraction image. Sometimes also an outline of the diatom crossing the field from one image to the other may be discerned.

The particular angles given to the prism now before the Society, were selected in order to enable a single prism to command the whole range of oblique illumination, and to enable so difficult an object as *Amphipleura pellucida* to be at once resolved whether in balsam or in air, and whether upon the slide or upon the cover. Through these facets, light at somewhat different angles may be

passed without practical detriment, as only the edges of the beam would become chromatized, or other angles may be given to the revolver prism. If two such prisms were to accompany the Microscope, one might be cut at angles of 25°, 30°, 35°, and 40°, in order to light objects to be viewed under high-angled light in air on the cover, or under low-angled light if in balsam. The second prism might be cut at 40°, 45°, 50°, and 55°, in order to light objects to be viewed on the slide in air with black background, or under the highest working angular apertures if in balsam. Difficult objects, when set upon the slide in air for black-ground illumination, require the cover to be very close down upon them, or they will not be resolvable by high-angled lenses.

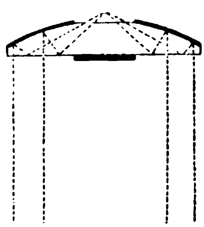
VII.—*A Catoptric Immersion Illuminator.*

By John Ware Stephenson, F.R.A.S., Treas. R.M.S.

(*Read 8th January*, 1879.)

As the subject of Immersion Illuminators is now before the Society (and I am very glad it is so, for without their help the full resolving powers of the recent large-angled objectives cannot be utilized), it may not be out of place to lay before the Fellows a brief account of an immersion condenser of very simple construction which I devised in 1877.

The diagram shows the form and size of the instrument which I now use, although it is sufficiently obvious that other sizes, in the same ratios, may easily be made—in fact, I have such.



The apparatus is simply a plano-convex lens, worked on a 1-inch tool, and having a diameter of 1·2 inches, which is then "edged" down to 1 inch, as being more convenient in size, and as giving an aperture sufficient for our purpose.

The upper, or convex side, of the lens is cut down or flattened, so as to give a surface $\frac{4}{10}$ of an inch in diameter, with which the slide is to be connected, when in use, by a drop of oil or water.

It matters not which fluid is used as long as the objective has a numerical aperture not exceeding 1·33 (the index of water), and it is very improbable that this will ever be exceeded to any *great* extent, as 1·50 is the *ideal* maximum of even an oil immersion.

The upper curved surface of the lens is silvered, and beneath the lens, a flat silvered plate $\frac{1}{80}$ of an inch thick, and corresponding in size and position with the upper flattened surface, is balsamed.

It will be seen that the incident ray is normal to the under surface, impinges on the curved silvered surface, and is thus thrown back on the plane, or under surface of the lens, whence the more oblique rays, falling beyond the critical angle, are totally reflected, and converge to a focus, giving a numerical angle of $1 \cdot 30 = 120°$ in balsam.

The object of placing a silvered glass disk beneath the lens is twofold: in the first place, it reflects the less oblique rays which fall within the critical angle, and in the second it tends to diminish the spherical aberration which in this zone might otherwise be felt.

The stop is placed about $\frac{1}{8}$ of an inch, or less, below the condenser, and the opening used is of a lens-shaped form, as giving a broad beam without any appreciable spherical aberration in so narrow a zone of light.

It will be found that this instrument will work through any ordinary glass slip, gives a brilliant light, and, having no refracting surface, is necessarily achromatic, whilst the spherical aberration, as previously pointed out, is inconsiderable.

If used with a dry lens of the highest power on a balsam-mounted object, the light, unable to pass the upper surface of the covering glass, is thrown back on the object, giving opaque illumination; on the other hand, with dry objects adhering to the slide, the well-known dark-ground illumination can be obtained with any objective I have yet seen.

VIII.—*The Thallus of the Diatomaceæ.*

By F. Kitton, Hon. F.R.M.S.

(*Read 8th January*, 1879.)

The study of the living diatom has lately engaged the attention of many eminent foreign diatomists (M. P. Petit, Paris; M. J. Deby, Belgium; Count Castracane, M. Ardres, and others). The latest published observations are those of M. le Dr. Lanzi, of Rome, in his paper * on the "Thallus of the Diatomaceæ." By thallus is to be understood the stipes, cushion, tube, frond, or mucous pellicle. The latter is the material by which the film of diatoms is attached to wet walls, buttresses of bridges, &c. He communicates some interesting facts connected with the reproduction of these remarkable organisms. "In a gathering of *Epithemia ventricosa* made in the Villa Pamphilia, in Rome, I observed that some portions of the pellicle were composed of a great quantity of round granular corpuscles of a greenish-yellow colour. Most of these corpuscles were, to all appearance, the same as those contained in the interior of the frustules of the Epithemia, and imbedded in a hyaline plasma. Such was the resemblance, that no one could doubt that the granular bodies in the plasmatic thallus and those in the frustules were alike.

"At another time I made a gathering in a fountain in the interior of the Forum of Trajan, of a Cymbella in a state of reproduction, and I was again able to see the round corpuscles. They were very small, and of the same colour as the endochrome. They were contained in the thallus, and resembled those in the frustules. I followed these germs through their phases of development; and by repeated observations I ascertained that, whilst increasing in breadth, they preserved their circular form; that afterwards they commenced to elongate, in order to acquire the lunate and naviculoid outline of the mature frustule.

"Of these growing forms, some remained attached to the thallus, and some became free. The number of these corpuscles was considerable; and one was easily convinced that they were the result of a new kind of generation. The disparity in size was so considerable, that it would have been absurd to suppose that they had been produced by fissiparity.

"I am able to report other similar facts observed in *Navicula ambigua*, *Nitzschia minutissima*, *Amphora ovalis*; but of these I shall say nothing, in order to avoid useless repetitions, and shall confine myself to describing *Gomphonema olivaceum* only, in which I have followed the series of transformations from the time the frustule containing the germs had changed into a sporangial cell,

* See 'Annales de la Société Belge de Microscopie,' vol. iv.

until the thallus became charged with germs and frustules in various stages of development. In this same thallus was also seen the gradual transformation of the corpuscles into rudimentary frustules, their growth, and lastly the development of the dichotomous peduncle. When this cycle was completed, the thallus contained three different forms—the sessile sphenelloid form, the pedunculate (either simple or dichotomous), and the perfect or free form. From the preceding, it appears that there arrives a time when the plasma contained in the siliceous cells acquire a considerable volume, owing to the rapid development manifested at the time of reproduction, and which cannot be contained within the walls of the frustule by reason of the want of elasticity produced by the deposition of silex. The frustules being unable to follow the growth of the plasma, the valves separate from the pressure; but previous to arriving at this condition, the protoplasm had commenced to undergo the changes necessary to the formation of the new cellules, and we are able to see an aggregation of hyaline masses destitute of an external membrane. These are the Moneres of Haeckel. Amongst them are some that remain for a long time as plastid gymnocytodes—that is to say, without an external membrane, as named by Haeckel—and form in this manner the amorphous or indefinite thallus (*mucus matriculis* of authors); whilst those that take the form of stipes, peduncles, cushions, or some definite form, appear to belong to the plastid lepocytodes, that is to say, invested with an extremely thin external membrane. This membrane, although scarcely visible with the Microscope, nevertheless limits the outline of the thallus. . . . I have determined to place the above-mentioned facts before diatomists, in order to call their attention to the study of the thallus of diatoms. The study of the function of the thallus in this large family seems to me to be full of interest."

The presence of this "thallus" is by no means uncommon. I have detected it in many diatomaceous gatherings, particularly those from fresh water, but I never saw the corpuscles Dr. Lanzi mentions; they may not have been present, or, what is equally probable, I overlooked them. However, the discovery is of great interest; and I hope, with Dr. Lanzi, that other diatomists will turn their attention to the study of the living forms. The reproduction of the Diatomaceæ has not received that amount of attention the subject deserved. Their increase by self-division was the method first observed, more careful observations led to the detection of conjugation and production of sporangial frustules, or the formation of a sporangium by a single frustule; and we now find that another method has been observed, viz. that just described by Dr. Lanzi.

The author's figure (1) represents a number of circular bodies immersed in the thallus of *E. ventricosa,* and also in the frustule;

(2) thallus of *Cocconema cistula*, representing the corpuscles in various stages of development. Unfortunately the amplification is not stated, a matter of some importance. It is also to be hoped that Dr. Lanzi will make some experiments to test the power possessed by them to resist desiccation without losing their vitality. In Herr Grunow's "New Diatoms from Honduras," 'M. M. J.,' vol. xviii. p. 184, Pl. 196, Fig. 4 *b*, is described and figured a curious abnormity of *Cerataulus lævis*. Within the large frustule are two very small ones. Herr Grunow asks, "In what manner do these abnormal frustules multiply and reproduce a new series of normal forms? Certainly not by conjugation or self-division." Professor Cleve* figures a frustule of *Biddulphia aurita* with a small frustule within. In a note (p. 184), I suggested "that the endochrome, under certain conditions, might possess the power of producing (? by means of microspores) perfect frustules without conjugation." Dr. Lanzi's discovery confirms my supposition, and explains the formation of the small frustules within the large one.

* 'Bihang till Vet. Akad. Hand.,' band i. tab. iv. fig. 3 *a b*.

NOTES AND MEMORANDA.

Researches on the Proboscis of Butterflies.—W. Breitenbach has undertaken a series of observations * on the hairs with which the proboscis of butterflies is covered, and on the relation of these to the curious "Cylindergebilde" or sheathed hairs by means of which many *Lepidoptera* are enabled to pierce the tissues of plants for the purpose of getting at the contained juices.

The ordinary typical hairs consist of a basal portion or cylinder composed of a dark chitinous material, and either partly imbedded in the substance of the proboscis or projecting freely from its surface, and of the hair proper, the proximal portion of which is imbedded in the cylinder, while the distal, usually by far the larger part, is free. In *Zygæna filipendulæ* the hairs on the greater part of the proboscis have the ordinary characters, but, near the free end of the organ, the edge of the cylinder is produced into four elevations, placed at equal distances from one another; the cylinder itself, moreover, is proportionally longer and the hair proper proportionally smaller than in the typical hair. In *Pieris* a similar structure obtains, but the cylinder is strengthened by longitudinal bands, one for each of the five points into which its edge is produced, and of a darker colour and firmer consistency than the rest of the cylinder. In *Epinephele Janira*, the size of the whole apparatus is greatly increased, the processes on the edge of the cylinder have become actual teeth, and the hair proper is so much reduced as to form a mere papilla just overtopping the circlet of teeth. A structure is thus produced eminently fitted for piercing the tissues of plants. A further modification occurs in *Arge Galathea*, in which, besides the row of teeth round the edge of the cylinder, there are three other circlets, encompassing, at equal intervals, its lateral surface: each of the four circlets is six-toothed. In *Catocala hymenæa* the structure seems at first sight to be altogether different: the cylinder is provided with six vertical plates standing out from its lateral surface, and projecting over its edge in the form of sharp points: these plates may be considered as having been formed by the coalescence of superposed rows of teeth, such as exist in *Arge*.

From these observations it seems highly probable that the sheathed hairs have been developed from ordinary hairs by the gradual diminution of the hair proper, especially of its extra-cylindrical portion, and by the simultaneous increase in size and strength of the surrounding cylinder. The advantage accruing to the insect from the change is obvious; with a proboscis provided merely with ordinary hairs it would be able to take advantage only of free nectar, that is juice actually poured out by the secreting glands of the plant, whereas with the sheathed hairs it would be able to pierce the cell-walls and derive an additional quantity of nutriment by drawing upon the internal juices. This view is supported by the fact that *Lepidoptera* visit flowers which produce no free nectar.

* 'Archiv f. Mik. Anat.,' vol. xv. p. 8.

Contributions to our knowledge of the Protozoa.—Professor A. Schneider has a short but important paper (with a plate) on this subject, in the 'Zeitschrift f. wiss. Zool.,'* in which he describes his recent observations on *Actinosphærium*, *Miliola*, *Trichosphærium* (a new genus), and *Chlamydomonas*.

Actinosphærium Eichornii.—Schneider's comparison of his own researches with those of Brandt, Greeff, and F. E. Schulze, lead him to think that this species really includes four distinct species, agreeing with one another in the vegetative condition, and differing only in the reproductive stage. The observations on which this opinion is based are shown in the following table compiled from Schneider's paper.

I. In the process of division the nucleus divides repeatedly, and a number of the nuclei thus formed pass into each of the resulting spheroids.	1. After the completion of the process of division, each of the two spheroids comes to lie in a special cyst, or rather in a special compartment of the common cyst: the spheroids do not subsequently unite, and their siliceous case is single (Schneider).	Species A
	2. After division the two spheroids do not, or not always, lie in special cavities in the cyst: after the process of division the two spheroids unite again: their siliceous case is double (Greeff).	B
II. In the process of division the nucleus disappears, new nuclei afterwards appearing, one of which passes into each spheroid: the siliceous cases are thinner than in (I.).	3. After division the spheroids conjugate (Brandt).	C
	4. Conjugation of the spheroids does not take place (Schneider, F. E. Schulze).	D

A further evidence of the distinctness of this form is afforded by the difference in their habits: of the two observed by Schneider, the species A, from the canal in the Berlin Zoological Gardens, fed chiefly on *Cyclops*, to which it clung by its pseudopodia, allowing itself to be carried about by its prey until the latter was killed: the species D, from ditches at Giessen, never devoured Cyclopidæ, but fed chiefly on *Chlamydomonas*, and amongst higher animals confined itself to the smaller Rotatoria.

2. *Development of Miliola.*—In a species of this genus observed at Föhr, distinct nuclei were observed. Multiplication took place by the protoplasm being divided into nucleated masses, of which there were finally seen to be two kinds; small naked cells, probably representing spermatozoa, and large oval cells provided with a distinct membrane, and seeming to represent ova. No stage was found between these latter, and germ masses, consisting of a very distinct cell-wall enclosing contents half protoplasmic, half fat like. The fatty body disappeared, and the germ was converted into a young *Miliola*, with a single, globular, thin-walled chamber, provided with one large aperture and several small ones, through which pseudopodia were protruded: no nucleus was visible in this stage. The tubular portion of the shell was seen to begin as a hand-shaped process near the mouth. The young *Miliolæ* continued to grow through the winter, and then the

* 'Zeitsch. f. wiss. Zool.,' vol. xxx. (Suppl.), p. 446.

formation of germs began anew, but this time, apparently, asexually, as no sperm-cells were seen.

In a vessel of sea-water containing *Miliolæ* from Heligoland, were found small sandy accumulations, containing a transparent, hardish substance, devoid of silica, and enclosing about fifteen spaces containing capsules. The contents of these capsules were of four kinds, firstly, a great number of bright *Euglena*-like bodies, devoid of flagella, but exhibiting movements, probably spermatozoa; secondly, masses of protoplasm, probably ova; thirdly, undoubted young Miliolæ; and fourthly, some of the capsules were empty and probably represented empty sperm-capsules.

It will be seen at once that the evidence for the sexuality of *Miliola*, brought forward by Schneider, is by no means complete.

3. *Trichosphærium Sieboldii* (nov. gen. et sp.).—This species was discovered in water from Ostend, where it existed in such quantities as to form a white powder. Its shape is generally ovoidal, but undergoes considerable changes, so slowly, however, that the changes could not be followed by the eye. The surface is thickly covered with long bristle-like filaments (Borsten), which are unaffected by potash, but dissolve in dilute acetic or hydrochloric acid, without evolution of gas. When these bristles are dissolved, the animal is seen to be covered with a fine membrane produced into short cylindrical tubular processes, through each of which a delicate protoplasmic filament, slightly longer than the bristles, is protruded. *Trichosphærium* forms an intermediate genus between *Lieberkühnia* and the ordinary calcareous Foraminifera.

4. *Chlamydomonas.*—The author describes three species of this alga, *C. pulvisculus*, *C. tumida*, and *C. radiosa*, and also gives an account of the conjugation in the first-named species.

Cochineal for Staining.—Dr. Paul Mayer,* of the Zoological Station at Naples, when making experiments to find an alcoholic carmine solution with which to stain satisfactorily entire chitinous membrane, tried the tincture of cochineal, which not only answered the desired purpose, but showed itself suitable for general application wherever it is required to stain by an alcoholic method animal tissues preserved in alcohol, and to keep the preparations thus obtained in a resinous medium.

The pulverized cochineal is left for several days in contact with 70 per cent. alcohol, 8–10 c. cm. to a gramme, and the dark red liquid filtered. *The object to be stained must be free from acid*, and it is best to lay it for some time previously in fresh alcohol of 70 per cent. According to the intensity required and the nature of the object, the staining takes from a few minutes (infusoria, marine larvæ, &c.) to a few days (the higher crustacea, large annelida, young cephalopoda, organs of vertebrata, &c.).—The subsequent removal of the staining material which is not fixed in the tissue, is effected with 70 per cent. alcohol, and takes days in some cases; it can never, however, be continued too long, and should not be stopped until the alcohol takes no more up.

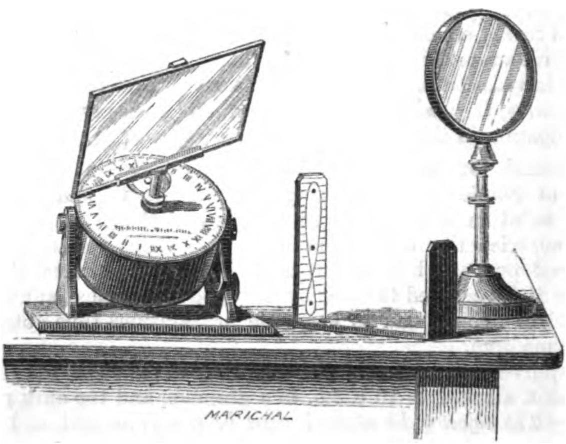
By this method, assuming that the object has been properly preserved, a very precise and nearly always intense nucleus stain is obtained,

* 'Zoologischer Anzeiger,' vol. i. p. 345.

and in by far the majority of cases this is not, as might be expected, coloured red, but hæmatoxylin. Dr. Mayer expects to be able to give the explanation hereafter of this strange phenomenon, which, however, is no detriment to the process. In consequence of the precision and tint of the stain, the preparations are for the most part not to be distinguished from those obtained with hæmatoxylin. The cochineal tincture also possesses, in common with the well-known alcoholic hæmatoxylin solution of Kleinenberg, the property of not altering the tissues; on the other hand, it compares favourably with it in the simplicity of its production and application, as also in the hold taken by the stain, which in this respect is equal to carmine. On the other hand, there is the defect that hitherto the attempt to stain large objects sufficiently deeply has not always succeeded; although the spinal marrow of the calf, in pieces one centimetre long and more, could be stained uniformly and deeply enough.

With a little care, permanent overstaining need not be feared, and can be removed by washing in acid alcohol (a drop of muriatic acid to about 10 c. cm. of 70 per cent. alcohol).

Prazmowski's Heliostat.—The woodcut represents this instrument, which, it is claimed, is much less complicated and cheaper than any existing form, and more easily regulated. The drum contains, as usual, the clock movement, and rotates a mirror upon its axis once in forty-eight hours. On the circumference of the drum is a dial with



the hours marked upon it, the spaces between each hour being divided into intervals of ten minutes. The drum rests upon supports, which allow it to be inclined in such a manner as to make the axis of the movement coincide with the direction of the earth's axis at the place where it is used.

This direction, which is given by the latitude of the place, need not necessarily be known to the operator, the adjustment of the instrument with respect to the latitude and the declination of the sun corresponding to the day of the year, being effected at once, and, so to speak, automatically. The apparatus is fixed after adjustment in

the position which the latitude requires by a screw, which presses upon an arm marked with the degrees of latitude from 0° to 70°.

In order to adjust the instrument, it is placed on a perfectly horizontal surface; the mirror having been removed, a metallic rule (forming a diameter of the dial plate) is fixed, so as to slide easily on the axis of the movement, which traverses it like a spindle. This rule is terminated at its extremities by two perpendicular pieces, the shorter one being pierced with a small hole, the other marked with a division representing the equation of time and the declination of the sun for every ten days, connected by a continuous line. At the base of the shorter upright the rule has an aperture, through which can be seen the figures on the dial. To set the apparatus to the hour, the rule is turned round the axis like the hand of a watch until the exact hour and fraction of the hour at which the observation is made are seen in the aperture, and the division which represents it on the dial coincides with an index placed at the edge of the aperture.

For final adjustment it is only necessary to turn the instrument horizontally on the table, inclining it more or less on its support, until a ray of the sun, passing through the hole of the short upright, produces on the line of declinations placed on the opposite one, a small image of the sun which falls exactly on the point corresponding to the day of the year. This operation takes only a few moments, and is extremely easy.

This done, the instrument is adjusted; the screw on the circle of latitudes is tightened, the rule taken away, and the stem of the mirror is slid into the axis of the movement. The mirror can be turned independently, by which means the reflected ray may be directed to any azimuth. A fixed horizontal ray is thus obtained, which may be further reflected to another plane mirror, placed at some distance and movable on a pedestal, so that the ray may be directed wherever it is wanted.

When the exact time is not known, the instrument may still be adjusted in a way which is approximately correct, by adjusting it at *about* noon. It may also be adjusted first at about 9 A.M., and then about 3 P.M. Each time this is done a line is drawn on the table with a pencil, the foot of the instrument serving as a rule. These two lines form an angle which is bisected, and along the line which bisects it the foot of the instrument is placed. The latter is in this way adjusted for midday.

The clock movement has an anchor scapement, and could move a much larger mirror. A small dial placed on the drum and divided into sixty minutes, on which a minute-hand moves, allows the regularity of the motion to be verified. The dial of hours and the division for the days are enamelled, and consequently proof against weather. The whole apparatus is very portable.

New (Auditory) Sense-organs in Insects.—Professor Graber, of Czernowitz, announces* the important discovery of organs, probably of an auditory nature, which he has found, one in the antennæ of adult Diptera, the other in a larva of a species of the same order.

1. *Otocyst-like Organ in the Antennæ of Diptera* (Plate IV. Figs. 1, 1*a*, and 1*b*).—This was observed in *Syrphus balteatus*. The structure

* 'Archiv f. Mik. Anat.,' vol. xvi. p. 36.

is best made out by treating the fresh antennæ with 1 per cent. osmic acid, transferring to absolute alcohol, clarifying with kreosote, and mounting in Canada balsam.

The supposed otocyst is a brown, thick-walled, chitinous sac, provided with hairs internally, having a diameter of 0·027 mm., and lying free in the cavity of the terminal leaf-like segment of the antennæ, towards the inner side of the joint between that segment and the preceding one. Under a high magnifying power the chitinous wall of the sac is seen to be covered with rounded or angular areas, the *hair-plates*, which are about ·0044 mm. in diameter, and in the centre of each of which is a depression, the *hair-pit*, giving attachment to one of the *auditory hairs*, which project in a radial direction towards the centre of the sac. These hairs are about two-thirds of the radius of the sac in length and ·0009 mm. in diameter at the base, where they are somewhat swollen. They contain a distinct lumen. Running through the wall of the capsule are fine pores corresponding to the hairs. The chitinous capsule is surrounded by a layer of columnar epithelial cells, each of which corresponds to one of the hair-plates, and the whole epithelial sac thus constituted is again surrounded by a delicate tunica propria.

The first and second segments of the antennæ bear only isolated, scattered, almost spiny hairs, but the terminal segment has a regular and dense covering of two kinds of appendages—true covering hairs formed by elevations of the cuticula, and articulated hairs agreeing generally with those of the other segments. The antennary nerve comes direct from the brain, and first branches when within the basal segment. A quantity of fine filaments are given off in the second segment, and go principally to the outer spiny hairs, swelling out at their roots into spindle-shaped ganglia. The other hairs of the first and second segments receive their nerves directly from the principal stem. Between the second and third segments the nerve makes an S-shaped bend, and, passing through the aperture in the joint-membrane, divides into filaments as in the second segment. A large branch is seen to pass direct to the capsule, but the connection of its fibres with the epithelial cells, although very probable, has not been made out.

An essentially similar structure is met with in the antennæ of *Sicus ferrugineus*, and in that of a species of *Helomyza*; in the latter case there is a dark-edged globular structure, which Graber considers to be the sac of the otolith, and suggests that the otolith itself, of which nothing was to be seen, was probably dissolved out by the kreosote.

Exact physiological observations are, of course, required, before the auditory nature of their structure can be considered as certain; but Graber mentions Paasch's observations that flies when startled by a sudden noise raise the third joint of the antennæ, as if "pricking up their ears."

It is also requisite to know something of the development of the organ, as to whether it is formed as an invagination of the integument, and also of its distribution in *Tracheata* generally. With regard to the latter point, Graber states that he has found it in many members of the sub-order *Brachycera*, but not in either of the families *Muscidæ* or *Tabanidæ*.

Professor Graber expresses his doubt as to the auditory nature of the structure discovered by Leydig in the halteres of certain Diptera, and also dissents from the views of the same authority as to the olfactory functions of the special rod-like appendages found by him on the antennæ of many Arthropods.

Plate IV. Fig. 1.—Right antenna of *Syrphus balteatus*, *Deg.* (in optical section). I., II., III., the three segments; *St*, Integument of epicranium; N, Antennary nerve; n^{I}, n_{II}, n_{III} and n_{IV}, its first, second, third, and fourth branches; *m*, m^1, Muscles of the basal segment; *Tr*, Trachea; *tr*, its vesicular dilatation in the terminal segment; *ga*, Ganglia at the base of the articulated hairs; *g*, Joint between the second and third segments; Ö, Opening in the same, through which the antennary nerve passes; *gc*, Auditory sac surrounded by its epithelium and *tunica propria; a*, Wall of the terminal segment, with the investing hairs and the roots of the articulated hairs. Amplification $\frac{180}{1}$ Zeiss Immers. L.

Fig. 1 *a*.—The otocyst (in optical section). *hh*, Auditory hairs; *hp*, Hair-plates; *hpo*, Pore-canals in the wall of the chitinous capsule corresponding to the auditory hairs; Z, Epithelial cells of the auditory sac; *tp*, Tunica propria. Amplification $\frac{1100}{1}$ Zeiss Immers. L.

Fig. 1 *b*.—The chitinous capsule of the otocyst (surface view). *w*, Wall; *hp*, Hair-plate; *h*, Root of the auditory hair; *hg*, Hair-pit; *fu*, Furrow between the hair-plates. Amplification $\frac{1100}{1}$ Zeiss Immers. L.

2. *New Organ in the Larva of a Fly* (Plate IV. Fig. 3).—In this case the main structure was made out by simply placing the transparent maggot under the compressorium. The organ in question is situated in the middle line of the dorsal side of the body, immediately posterior to the line of junction between the ninth and tenth segments. It is a pear-shaped sac, 0·3 mm. in length, with its narrow posterior end produced into a fine tube. It seems probable that tube and sac together are formed as an invagination of the external surface.

The sac and tube are made of a layer of epithelial cells, covered externally by a tunica propria, and lined within by a chitinous cuticle which bounds their lumen. Within the sac are contained four pairs of black opaque bodies of an irregularly rounded form, and suspended by hollow stalks. The first two pairs are of about equal size, being 0·03 mm. in diameter. The length of the stalk is 0·026 mm., and its breadth at the point 0·0018. The third and fourth pairs are smaller, and are only 0·02 mm. Probably the bodies themselves are also hollow, and have very thick, strongly chitinized walls, but their exact structure could not be made out, as they remained perfectly opaque even after treatment with potash. The most anterior pair of these bodies are attached, like berries, to the front wall of the sac; immediately behind them is a chitinous partition separating this anterior segment of the sac from the remainder. The second pair are not attached directly to this partition, but to the front wall of a special cellulose capsule (Binnensack), quite separate from the true

lining of the sac, closed anteriorly, but merely constricted behind. Similarly the third and fourth pairs of bodies, which are in close contact with one another, are connected to the front wall of another sac, the anterior closed end of which fits into the neck of the former, while its own neck extends nearly to the apex of the main sac. Probably these capsules are outpushings of the chitinous lining of the main sac.

It will be seen that there are thus formed three capsules, the actual lining of the sac and the two "Binnensäcke," which enclose one another like the coats of an onion, so that while the first pair of stalked bodies has only one layer of chitinæ outside it, the second pair has two, and the third and fourth pairs three.

The author, "proceeding by the process of elimination," points out that the organ must be either a gland or a sense-organ, and after going over the arguments for and against, comes to the conclusion that it cannot be a gland; and, further, that partly from its position and partly from its structure it cannot be intended for touch, smell, taste, or vision, and must therefore be a true auditory sac. The stalked bodies he considers to be otoliths, acting from their mode of attachment like the clapper of a bell.

Plate IV. Fig. 2.—The dipterous larva—natural size—showing the position (x) of the supposed auditory organ.

Fig. 2*a*.—The organ, isolated. K, Fundus of the sac; *Sp*, its apex; *ep*, *Ke*, its epithelium; *Ca*, Chitinous sac; s_1, s_2, s_3, its three internal capsules ("Binnensäcke"); *e*, constriction in the neck of the second of these; *st*, Stalked bodies; *m*, Muscles; n_1, n_2, First and second nerves; *ga*, Ganglionic swelling on the first of these; *n*, branch of the second; *r*, Tubular prolongation of the sac. Amplification $\frac{400}{1}$ Zeiss Immers. L.

At the end of his paper Graber gives the following useful diagram, showing in a tabular form the various forms of auditory organs occurring in the animal kingdom.

CHIEF FORMS OF AUDITORY ORGAN.

Elementary Auditory Organ. Isolated auditory cells and auditory hairs.	*Sac-like Auditory Organ, or Cystic Form.*	*Tympanic Form* (with auditory rods).
Lower animals (?). Crustacea. Insects (?).		**Orthoptera.**

Sac-like Auditory Organ divides into:

Wall consisting of cells only. *Gymnotocysts.*		Wall with a chitinous cuticle. *Chitinotocysts.*	
With ciliated cells. *Ciliotocysts.*	Cells without cilia. *Non-ciliated gymnotocysts.*	With hairs. *Piliotocysts.*	Without hairs. *Apilose chitinotocysts.*
A- / Mono- / Poly- lithophorous.	Polylithophorous, **Ptychoptera.** With rosette-like central organ.	A- / Mono- / Poly- lithophorous.	With stalked otoliths (?).
Cœlenterata (?). Vermes. Mollusca. Vertebrata.	**Larva of Corethra and Chironomus (?).**	**Crustacea. Insecta** (antennary otocysts).	**Fly larva.**

The Fibrillæ of Filifera.—Oscar Schmidt has recently given an account * of the curious fibrillæ found among the ordinary horny fibres of the sponge *Filifera*. These bodies occur in the form of fine knobbed fibres, agreeing in chemical and microscopical character with the fibres of *Euspongia*, except for the fact that a cell-like body is regularly developed in the knob, when the latter separates from the softer axial portion of the fibrilla. Less frequently the formation and subsequent separation of one or two similar bodies occurs in the axial portion itself. Division of the fibrillæ also takes place.

Kölliker doubted whether the fibrillæ might not be parasites; but this conjecture is erroneous, as also is the former opinion of Oscar Schmidt himself, that they arise from the ordinary coarse fibres of the horny skeleton. The difficulties attending their isolation are so great, that the author has only recently succeeded in accomplishing it, thus making out for the first time their true form. He states that the perfect fibres are knobbed at both ends and resemble children's skipping-ropes. Their dimensions are subject to remarkable fluctuations, the long diameter of one and the same knob varying from 0·008 to 0·01 mm., and the length of a carefully isolated fibre from 1·4 to 1·6 mm.

The Ovule.—M. E. Warming, the Danish naturalist, has published in Danish the results of his investigations on the ovule. A translation in French appears in the 'Annales des Sciences Naturelles' (occupying more than 70 pp.), from which the following (being the author's "Conclusion") is extracted:—

I. Few organs have been the object of such varied interpretations as the ovule. Some (Schleiden, St. Hilaire, A. Braun, Strasburger, Wigand, Eichler, &c.) consider it as a bud, of which each integument is an independent leaf, or a disk (Schacht, Endlicher, Unger); the others as an organ of a foliar nature, in which the funicle alone (Rossman), or the funicle and the integuments, is an ovular leaflet or a lobe of a leaf. From this point opinions diverge. According to some, the nucleus is a part, a tooth of this leaf (Reissek); according to others, a new creation. In the latter case it is sometimes regarded as a bud (Caspary, Rossman), sometimes as a metablast, and latterly as the homologue of a sporangium (Brongniart, Cramer, Tieghem, Celakovsky). I agree with the latter opinion. There are also some observers who consider that the ovule may have a different signification in one plant and another, relying on its position either on the summit of the axis or on a leaf. I was formerly of the same opinion, but, thanks to the excellent reasoning of M. Celakovsky, I have recognized that the morphological signification of an organ does not depend absolutely on its position. Considering the perfect concordance in the structure of all the ovules of the Angiosperms, even those inserted on the most diverse organs, this opinion is inadmissible; and comparative study has done complete justice to it in negativing the idea that the organ which is the sporangium in the Cryptogams, may become a bud in the Phanerogams.

It has been desired to invoke the law of shifting, according to

* 'Zeitsch. f. wiss. Zool.,' vol. xxx. p. 661.

which the same physiological functions can be exercised by organs which are very different morphologically, and it has hence been concluded that that *must* be true for the ovule—though it may be possible, it does not necessarily follow that it is so. I pass by this illogical reasoning, therefore, until there has been discovered a well-established fact showing that the functions of the ovule are fulfilled by an organ which cannot be assimilated to a sporangium. A. Braun recognizes "that an organ analogous from a phylogenetic point of view to a sporangium developed on a leaf, and to the pollen sac of the staminal leaf, should be considered as an excrescence of the carpel;" but he adds that "in its ulterior development it may be elevated to the dignity of a vegetative point producing some leaves in the form of sheaths destined to protect the organ of reproduction which is formed on the vegetative summit itself." In other words, that an organ of any morphological nature whatever may be transformed into another of superior dignity. These considerations are so wanting in foundation, they are so opposed to observed facts, that I can see nothing else on the part of the celebrated morphologist than an attempt to sustain, notwithstanding its contradictions, a favourite theory, but one nevertheless that cannot be supported.

II. I sum up briefly my results and my arguments, in comparing the different ovular theories.

The theory according to which the ovule is a bud has found support in the terminal position of a great many ovules, which makes them appear as the direct continuation of the axis. But M. Celakovsky has shown that the terminal position (or generally any position whatever of an organ) cannot demonstrate its morphological value, since there exist, for example, terminal leaves. He has proved that the part of the pistil which carries the ovule is everywhere of a foliar nature, even in the case of a central free placenta. In this he is of the same opinion as M. Van Tieghem, who has pursued an entirely different line. I agree in this opinion, and I have endeavoured to show that the history of development, in general very ineffective in similar questions, teaches us that the placenta or the terminal ovule in certain cases is a new creation on the summit of the axis. Amongst the Gymnosperms we find at first in the Cycadaceæ true carpellary leaves, and it has been established that the scales which bear the ovules in the Abietineæ are of a leafy nature, even when the scale cannot be interpreted as the fertile ventral part of the protecting scale, as I have mentioned hypothetically in my work on the Cycadaceæ. The concordances in the structure and anatomy enable us to admit that it is true also for the other Conifers (with non-terminal ovule). For the *Gingko* the ovular organ situated in the axil of the scales of the bud or of the leaves, must be considered as being composed of two leaves joined together, belonging to an axillary bud, like the needle of *Sciadopitys*. The two parts are even placed in the same manner, the physiologically lower face being turned towards the principal axis. Amongst the Cupressineæ and other Conifers with scales apparently simple, the union of two organs must be admitted, with MM. Van Tieghem and Strasburger. I admit that I am not able to apprehend in all its details the disposi-

tion of the ovule in *Taxus*, but I will willingly take it for a terminal leaflet with a monangian sorus equally terminal.

The carpels of the Angiosperms are distinguished from those of the Gymnosperms in that the former bear the ovules on the superior face, the others on the inferior when the ovules are not exactly marginal. The same observation applies to the stamens, those of the Conifers and the Cycadaceæ carry the pollen sacs on the inferior face, those of the Angiosperms on the superior face or at the side.

M. Celakovsky compares the stamen of the Angiosperms to the leaf of the *Ophioglossum*. Assuredly there is here a very ingenious comparison, but one which can only be placed in the category of bold and somewhat vague hypotheses founded on a too restricted number of observed facts.

The terminal position of the ovule does not prove that this organ is a bud; on the contrary, the placentæ must be everywhere phyllomes.

The mode of development of the ovule, especially that of the Conifers, should tend according to some authors to its being considered a bud. It is impossible to have confidence in the history of development when the question is to determine the morphological nature of an organ. It everywhere requires a correction. M. Strasburger has allowed himself to be too much guided by preconceived ideas in the interpretation of the phenomena of development. Moreover, I have shown that the histogenesis of the ovule, as he has described it, is not correct, especially in relation to the development of the nucleus.

MM. Celakovsky and Cramer have shown that teratology cannot be invoked to prove that the ovule is a bud. The theory of Brongniart is much more admissible. In the first place, the carpels and the placentas are phyllomes; that being so, it is difficult to admit that the ovules are buds. It is true that buds may grow on a leaf, but to admit that the ovules are similar buds developed regularly on a carpellary leaf requires reasons of great weight. Moreover, the descending progression of the integuments is not in accord with this theory.

Secondly, the teratological cases show us everywhere the ovule (funicle and integuments) transformed into a lobe of a leaf on which the nucleus is a new creation, in the light of an outgrowth: this fact is confirmed by histogenesis. I may recall here that two nuclei have sometimes been observed on the same ovular leaflet, which does not agree with the theory of Braun, but very well with that of Brongniart.

Thirdly, the development of the nucleus is so like that of the pollen sac of the Angiosperms, that their homology cannot be doubted: further, the pollen sac itself is the homologue of the sporangium; therefore the nucleus must be compared to the macrosporangium. I do not know why it should be given the name of "sporocyst," which can scarcely be applied to any but the Marattiaceæ, for M. Strasburger has not yet demonstrated that the sporangia of the Equisetaceæ and the Lycopodiaceæ are sporocysts. This name could better be given to the pollen sacs of the Angiosperms.

The sporangia of the Cryptogams all grow on the leaves. The

comparison of the nucleus to the sporangium and to the pollen sac, confirms the results which we have obtained by the comparative study of the carpel.

The insertion of the nucleus on a leaf is proved for the Gymnosperms and a part of the Conifers; it may also be admitted in a general way for the other part of this family, but the details are still unknown.

The Gymnosperms, however, differ notably from the Angiosperms in several points, and constitute a separate branch which has not the same origin. The following are some of the differences which separate them: the forcing down of the female sporangium; the origin of the integument in two primordial points in a part of the genera; the development of the proembryo and the embryo; the disposition of the pollen sacs, and (in part) of the ovules on the staminal or carpellary leaf.

As the pollen sacs, wherever their position has been clearly recognized, are borne on the leaves; as all the facts, in the obscure cases, seem to indicate the same thing; as that is true for the ovule; as the sporangia of the Cryptogams, the common and primitive form of the phanerogamous reproductive organs, are equally developed on leaves, it must be admitted as a general rule that the reproductive organs of all the vascular plants are borne on the leaves, and that morphologically they are metablasts.

I shall be pleased if this memoir should contribute to the general acceptance ere long of the theory of Brongniart, the only true and admissible one—that I am now convinced of it is due in great part to the ingenious Slave botanist, Ladislao Celakovsky.*

Laboratory for Microscopic Work.—In the Zoological Laboratory at Newport, Rhode Island, U.S., recently established by Professor Alexander Agassiz, the tables for microscopic work are three-legged stands, of varying height, adapted to the different kinds of Microscopes in use. The whole of the northern side of the floor upon which the work-tables and microscope-stands are placed, is supported upon brick piers and arches independent of the main brick walls of the building, which form at the same time the basement of the building. The rest of the floor is supported entirely upon the outside walls and upon columns with stretchers extending under the crown of the arches reaching to the northern wall. This gives to the microscopic work the great advantage of complete isolation from all disturbance caused by walking over the floor. This will be duly appreciated by those who have worked in a building with a wooden floor, where every step caused a cessation of work and was sure to disturb any object just at the most interesting moment.†

A New Micrometer.—Spider-line micrometers, or micrometers of fine threads of platinum, are inconvenient from the thickness of the threads, from their expansion or contraction under thermic or hygrometric influences, from the difficulty of fixing them parallel to

* 'Ann. des Sc. Nat. (Bot.),' 6th series, vol. v. p. 250.

† 'Am. Jour. Sci. and Arts,' vol. xvi. p. 488.

each other at very small distances, or from their breaking so easily, and the difficulty of replacing them without the help of an expert.

In a micrometer devised by M. G. Govi,* the threads are replaced by the two edges of a slit made in a very thin layer of silver, gold, platinum, or other metal deposited on the surface of a glass slide which has its faces perfectly plane and parallel. Such metallic coatings may be obtained sufficiently opaque with a thickness of less than a hundred thousandth of a millimetre. The slit is made by a steel tracer so lightly as not to touch the glass. The breadth of the slit depends on the fineness of the tracer, its neatness not only on the shape of the tracer, but also on the thinness of the metallic layer. When broad slits are wanted it is best to remove the metal in parallel furrows rather than attempt to attain the same result by a larger tracer, which might produce slits with irregular edges. The metallic layer should be placed on the side whence the image comes, so that the rays which emanate from it, and the light which grazes the edges of the slit, may have to traverse the same thickness of glass and undergo the same modifications.

In consequence of the extreme thinness of the metal coating, the strongest eye-pieces give no sensible thickness to the edges of the slit. There is therefore nothing to fear from the effects of parallax even when the micrometer is applied to images placed in the extremities of the field.

There should always be a portion of the metallic coating removed normal to the slit, so as to allow the observer to see the images when they appear on the field of the Microscope, and when they pass off between the edges of the slit. It is a good plan to remove a little less than half the opaque coating, leaving intact the other half where the slit is. It is equally practicable to take off two equal bands of metal at the two extremities of the slit, and leave only the central zone in the field, which need not be very broad.

If a number of slits of different width be made on one plate, it is possible to avoid employing several micrometers.

The extreme tenuity of the metallic coating, its opacity, its rigidity, and the fact of its not altering under considerable thermometric and hygrometric variations; the possibility of making slits as narrow or wide as desired; the facility of substituting different slides in the same frame, are advantages in this micrometer which should, as it seems to me, induce observers to use it in place of the thread micrometer.

"**Cell-Soul and Cellular Psychology.**"—Professor Haeckel has recently published his reply to the address on "The Liberty of Science in the Modern State," delivered at last year's meeting of the German Association, by Professor Virchow. He states that the views he expressed at Munich with regard to the soul of the cell, i.e. "that we must ascribe an independent soul-life to each organic cell," are but the natural consequence of Virchow's own teachings, viz. of the very fertile application which Virchow made of

* 'Comptes Rendus,' vol. lxxxvii. p. 557. The micrometer as described is intended more especially for meteorological observations.

the cell theory to pathology. He then proceeds to give the definition of the word "soul" according to both philosophical theories. First according to the monistic or realistic theory (i.e. that organisms have been *developed* naturally, in which case they must descend from the simplest and common ancestral forms), and then according to the dualistic or spiritualistic theory (i.e. that the different species of organisms have originated independently of one another, in which case they can only have been *created* in a supernatural way—by a miracle), he compares the simplicity of the former with the mystery and irrationality of the other, and shows the futility of Virchow's view that we cannot find psychic phenomena in the lower animals. "Volition and sensation, the most general and most indubitable qualities of all mental life, cannot be overlooked in the lower animals. Indeed, with most *Infusoria*, particularly with *Ciliata*, independent motion and conscious sensation (of pressure, heat, light, &c.) are so very evident, that one of their most patient observers, Ehrenberg, maintained up to his death that all *Infusoria* must have nerves and muscles, organs of sense and of mind (*Seelenorgane*), just like all higher animals.

Now it is known that the enormous progress which science has recently made in the natural history of these low organisms has reached its climax in the maxim that they are *unicellular* (a maxim which Siebold pronounced thirty years ago, but which has been proved with certainty only recently); therefore in the *Infusoria a single cell* performs all the different functions of life, including the mental functions, which in the *Hydræ* and *Spongiæ* are divided amongst the cells of the two germinal lobes, and in all higher animals amongst those of the various tissues, organs, and apparatus of a complicated organism. . . . By the same right by which we ascribe an independent 'soul' to these unicellular *Infusoria*, we must ascribe one to all other cells, because their most important active substance, the protoplasm, shows everywhere the same psychic properties of sensitiveness (sensation) and movability (volition). The difference in the higher organisms is only that there the numerous single cells give up their individual independence, and like good state-citizens, subordinate themselves to the 'state-soul' which represents the unity of will and sensation in the 'cell-association.' We must distinguish between the central soul of the total polycellular organism or the 'personal soul' and the separate elementary souls of the single cells, or 'cell-souls." This maxim is excellently illustrated by the interesting group of *Siphonophora*. There is no doubt that the whole *Siphonophora*-state has a very determined and uniform (*einheitlich*) will and sensation; yet each one of the single individuals which compose this state (or *Cormus*) has its separate personal will and sensation. Indeed, each one of these is originally a separate *Medusa*, and the 'individual' *Siphonophora*-state has resulted only by association and division of labour of this united society of *Medusæ*. Next to the unicellular *Infusoria* no phenomenon affords such ample and immediate proof for the truth of our cellular-psychology than the fact that the *human ovum*, like the ovum of all other animals, is a simple

and single cell. According to our monistic conception of the cell-soul, we must suppose that the fertilized ovum already possesses *virtually* those psychic properties which in the particular mixture of parental peculiarities (i. e. those of mother and father) characterise the individual soul of the new being. In the course of the development of the ovum the cell-soul of course develops itself simultaneously with its material substratum, and becomes apparent *actually* when the child is born. According to Virchow's dualistic conception of the 'Psyche,' we must suppose, on the contrary, that this immaterial being enters the soulless germ at some period of embryonal development (perhaps when the spinal tube separates from the germinal lobe?). Of course in this way the pure *miracle* is complete, and the natural and uninterrupted *continuity of development* is superfluous." *

Post-embryonic Formation of Appendages in Insects.—H. Dewitz was led by Darwin's remarks in the 'Origin of Species,' on the difficulty offered to the doctrine of natural selection by the neuters of insects living in communities, to make some researches on this subject, the results of which he sums up as follows: †—

The workers of ants possess very small wing-disks, situated precisely as in winged insects, and undergoing subsequent retrogressive metamorphosis. A figure is given, showing a rudiment of the posterior wing in an adult worker.

The thoracic appendages of ants first appear as a disk-shaped thickening of the hypodermis, which becomes separated into a central portion, the rudiment of the leg or wing, and a surrounding membrane; an aperture, opening outwards, being left in the latter. The membrane grows as a sack- or pocket-shaped invagination, into the interior of the body, and when metamorphosis takes place, the original aperture is enlarged to allow of the extrusion of the limb.

The young thoracic appendages of ants and bees secrete a chitinous cuticle during the larval condition. The difference between the limbs, formed during post-embryonic life, of *Holometabola* and of *Ametabola*, does not consist in the formation or non-formation of this cuticle, but in the fact that in *Holometabola* the newly formed appendages lie for the most part concealed in invaginations of the hypoderm, making their appearance first in the pupa stage, while in *Ametabola* they are visible from the first.

The formation of the wings of *Lepidoptera*, and, in the author's opinion, that of the appendages of all insects, takes place from the hypoderm, although probably their internal differentiation is always brought about by the penetration into them of nerves, tracheæ, &c.

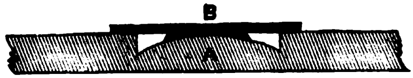
The main difference between the females and workers of ants is not produced as in bees, by a different treatment of the eggs or larvæ on the part of the adult workers, but the future fate of the egg is settled while still in the body of the mother.

The Weber Slide.—The well-known live-box or animalcule cage serves the purpose of preserving and exhibiting living objects very

* 'Nature,' vol. xix. p. 113.
† 'Zeitsch. f. wiss. Zool.,' vol. xxx. (Suppl.), p. 78.

well, but it does not entirely prevent the evaporation of the liquid in which the objects are contained. The ordinary concave slide, though better than a plain slip of glass, does not fulfil all the requirements; and with such a slide it is difficult to keep the object in focus, except with very low powers.

To obviate these difficulties, Mr. Weber has reversed the form of the cell, and forms his slide as shown in the accompanying engraving, where A is the convex bottom of the cell, and B the thin glass



cover, a drop of water being held between them by capillary attraction. When the cover is cemented down by means of a little waterproof cement, the water cannot evaporate, and the whole arrangement forms an air-tight aquarium on a minute scale. The open space forms a chamber which retains a supply of air, and if the animal and vegetable life are properly balanced, life may exist in one of these slides for weeks.

In the woodcut, which shows the slide, the thickness of the slide, &c., is magnified about four times.*

The form of the crystalline Cones in the Arthropod Eye.—Oscar Schmidt contributes a paper on this subject to the 'Zeitschrift f. wiss. Zool.'† He commences by a short statement of the views of Exner and of Grenacher, the latest writers on the subject, and remarks that both they and all their predecessors consider each visual cone to be perpendicular to the corresponding corneal surface, so that only those rays of light which strike the cornea at right angles are of any avail in the formation of an image, being able to pass unbroken and unreflected to the apex of the cone.

The author then proceeds to describe the visual rods in the amphipodous genus *Phronima*. This animal possesses two pair of eyes: *lateral eyes* (Seiten-augen), situated in the usual position at the sides of the anterior part of the head, and in the same transverse section as the brain; and *frontal eyes* (Stirn-Scheitel-Augen), placed at the vertex of the head, very far posterior to the brain. Each eye is supplied with nerve-fibres from the optic ganglion, which fibres enter a mass of pigment of a brown or yellow colour visible with the naked eye, and become surrounded with a sheath closely adherent to the pigment. The pigmented body of the lateral eye is comparatively small, that of the frontal eye large and spindle-shaped; with it are connected, in each case, the proximal ends of the visual rods or crystalline cones, the distal ends of which abut against the external surface. In the lateral eye no two cones are found alike: those of the central portion of the organ approach most nearly to the conical form, and even they are not really conical, having an almost globular distal extremity or head, and a spindle-shaped swelling near the proximal end, where they become continuous with a nerve-fibre. In the frontal eye the visual rods are

* 'American Journal of Microscopy,' vol. iii. p. 253.
† 'Zeitsch. f. wiss. Zool.,' vol. xxx. (Suppl.), p. 1.

even less truly conical; each consists of a conical or rather globular head, a long central filamentous portion, and a proximal spindle-shaped portion. There is no cornea in either the lateral or the frontal eye, but the distal end of each cone comes into relation at the surface with a double cell, containing two (Semper's) nuclei. These double cells do not fit closely to one another, but leave triangular interspaces: the boundary wall between the two halves of which they are composed penetrates into a very evident cleft, marking the division of the cone into two longitudinal segments. Schmidt's observations give no support to Pagenstecher's view that this separation of the cone into two longitudinal moieties is an evidence of multiplication by division.

But perhaps the most important observation on these cones is that in hardly a single case is the axis of the visual rod at right angles to the external or corneal surface, so that Müller's theory of mosaic vision is here quite inapplicable, since there is neither the straightness of the refracting bodies, nor the contrivance for absorption of lateral rays required by that view of the action of the so-called compound eye. The author considers that the eyes of *Phronima* are mere makeshifts for image-forming organs, and that they serve only to distinguish different degrees of light and colour.

Observations on the visual rods of other Crustacea showed that in *Palæmon* many of the cones are straight, but that those at the periphery of the organ are oblique to the corneal facets, their proximal segments being strongly bent. In *Palinurus* this flexure sometimes amounts to 90°. In the lobster the rods are very irregular, hardly two being alike: their proximal segments show the greatest amount of variability as to size and degree of flexures, and have no resemblance at all to image-forming bodies.

The only insect examined by the author is *Dytiscus marginalis;* in it, as in the prawn, he finds that the rods towards the periphery of the eyes exhibit a marked flexure. The paper is accompanied by a plate.

Poison Glands of the Centipedes.—It has long been known that the Chilopod Myriapoda, commonly known as centipedes, which are carnivorous in their habits, kill their prey by a poison injected at the first bite of their formidable nippers. The seat of the glands secreting the poisonous fluid was, however, unknown, the organs formerly supposed to secrete the venom being found to pour their secretion into the cavity of the mouth and not into the nippers. Mr. McLeod, during a residence in Java, examined some of the large centipedes with which that island abounds, and especially *Scolopendra horrida*, and finding the glands which might easily be taken for poison glands had nothing to do with the nippers, which nevertheless always exhibited a very distinct orifice at the tip, he was led to search for the glands in the interior of those organs themselves.

The process he adopted is one that has of late given admirable results in the investigation of the anatomy of many animals; namely, the preparation of sections of them in various directions, after they had been immersed in melted paraffin, the subsequent hardening of which keeps all parts in their natural positions during the operation of cutting. By this means he detected the poison gland, which is

situated partly in the actual biting portion of the nipper and partly in the broad basal joint which supports the latter. The glandular apparatus consists of a chitinous duct leading to the orifice at the apex of the organ, and forming the axis of the gland. It is perforated in its course by a multitude of small apertures, each of which leads into a minute cylindrical tube, terminating in a long secreting cell, the whole mass of these cells being arranged in a radiating fashion around the duct. The entire organ is surrounded by a membrane, and has the general form of a four-sided prism. Notwithstanding its comparatively small size, Mr. McLeod has detected the same arrangement in *Lithobius forficatus*, the common European centipede.*

Microbia.—Under the title of "The Influence of M. Pasteur's Discoveries on the Progress of Surgery," M. Sédillot contributes a paper to the French Academy,† which he commences by pointing out that the microscopical organisms pervading the atmosphere (which Pasteur has shown are the cause of the fermentations attributed to the air, which is merely their vehicle), form a world by themselves, the history of which, as yet in its infancy, has already proved fertile in conjectures, and in results of the highest importance.

The names of these organisms are, however, very numerous:—Microzoaria, Microphyta, Aerobia, Anaerobia, Microgerms, Micrococci, Microzymes, Bacteria, Bacteridia, Vibrions, Microderms, Confervæ, Ferments, Monads, Animalcules, Corpuscles, Torulæ, *Penicillium*, *Aspergillus*, Infusoria, *Leptothrix*, *Leptotrichum*, Spores of *Achorion*, of *Favus*, of *Oïdium*, of thrush, Organisms of right and left tartaric acid, septic and septicemic Zymes, &c., terms which need to be defined and partly reformed. The word Microbia (from *mikros*, small, and *bios*, life) has the advantage of being shorter and of a more general signification, and of being approved by M. Littré, the most competent linguist in France; and the author therefore proposes it for general acceptance, without, however, laying aside altogether those terms in use to designate varieties which have been more particularly examined. M. Pasteur also approves of the term.

The paper proceeds to discuss the changes in surgery which were brought about by the proof of the existence of Microbia, and "which threw a vivid light on the obscurity and false conceptions in which surgery had gone astray. From the highest antiquity medical science took notice of the preponderating influence of the air on health and disease; but, in spite of the immense progress of science, time brought about no change in this point of view until the discoveries of M. Pasteur essentially modified the position of surgery and the treatment of wounds in particular. Surgeons were divided by different doctrines, reducible to a single one having for its basis 'the dangers of contact with air.' All were founded on observations which were exact and approached to truth, without, however, attaining it by reason of false interpretations and hasty generalizations. The discoveries of M. Pasteur at once reconciled the apparent contradictions, and explained the

* 'Bull. Acad. Roy. de Belgique,' vol. xlv. 'Pop. Sc. Rev.,' N.S., vol. iii. p. 111.

† 'Comptes Rendus,' vol. lxxxvi. p. 634.

use, in the treatment of wounds, of pulverulents, styptics, balms, ointments, caustics, camphor, iodine, alcohol, and a hundred other antiseptic substances which act as barriers to the contact of Microbia, or as agents of their destruction. Herein lies the principle of all preservative and curative treatment. Medicine and hygiene is applied to the destruction of the Microbia, external and internal, and to augment the vital resisting power of the patient.

The cultivation in fluids of Cohn, Raulin, and Pasteur has shown that certain species of Microbia (*Aspergillus niger* amongst others) have never been found amongst the preparations impregnated by the passage of a given quantity of air. Yet to procure this cryptogam it suffices to expose a slice of moist bread to the air, when they are soon seen to grow. This fact fully explains the variety of accidents to which wounds may be subject by reason of the numberless modifying circumstances which render them more or less amenable to the development and increase of different Microbia." It would be very desirable, he thinks, "to set up apparatus for analyzing the air in hospitals by which the degree of salubrity or infection would be daily determined."

Orchella as a Staining Material.—Dr. C. Wedl, of Vienna, describes the following process of staining animal tissues, in Virchow's 'Archiv für Pathologische Anatomie,' vol. lxxiv. p. 143. The so-called French Orchella-extract, from which the excess of ammonia has been extracted by gentle warming in a sand-bath, is poured into a mixture of 20 c. cm. absolute alcohol, 5 c. cm. concentrated acetic acid (of 1·070 spec. grav.), and 40 c. cm. distilled water, till a saturated dark-red stain is obtained, which must then be once or twice filtered. After the section has been hardened in Muller's fluid and spirits of wine or chromic acid, it is washed with distilled water. The latter is then got rid of by means of blotting-paper, and some drops of the staining fluid are applied to the section. The stain is taken up immediately by the protoplasm of the cells, whilst nuclei and nucleoli are not coloured. Horny or calcareous epithelial formations likewise take no stain. Connective-tissue cells are very deeply coloured, whilst the fibrillated intercellular substance of the connective tissue takes less of the stain. The basic substance of bones and that of the teeth take the stain, also the ganglion-cells with their prolongations. Fresh pathological formations also give sharp images when coloured with orchella. As medium the author used *levulose*.*

Construction of Eye-pieces.—In consequence of the discrepancies in published statements in regard to eye-pieces, Mr. W. H. Seaman, of Washington, has made a full series of measurements of the parts of eighteen eye-pieces by English and Continental makers. As the result of these measurements (which were laid before the Indianapolis Congress †), it was found that the common ratio between the focal lengths of eye-lens and field-lens was $\frac{1}{2}$, in one instance it was $\frac{1}{3}$, and

* 'Zeitschrift für Mikroskopie,' vol. i. p. 318.
† 'American Naturalist,' vol. xii. p. 838.

in one of older construction $\frac{7}{9}$. "The only general principle in regard to the interval separating the lenses is, that it shall be less than the solar focus of the field-lens; and when in the deeper eye-pieces and those which are orthoscopic it seems to exceed this limit, it must be remembered that in connection with the objective the eye-piece receives diverging rays, and for such its focus is beyond the solar focus. It may also be noticed that but a small part of the diameter of the eye-lens is actually used in the lower powers."

Malpighian Vessels of Insects.—Dr. E. Schindler has published an account, with three plates and a woodcut, of his extended researches on these structures.* This paper gives, first, an general account of the structure of the vessels in question, then an historical summary of the work of former observers, then a special account of the Malpighian vessels in the various groups of insects, and finally some concluding remarks, summarizing the results at which he has arrived. It is only possible here to give some account of the first and last of these sections.

The Malpighian vessels consist of at least three layers: externally a serous coat of nucleated connective tissue, then a delicate homogeneous tunica propria, and finally a single layer of glandular epithelial cells bounding the lumen of the tube. To these is sometimes added a perforated cuticular tunica intima. Elastic and muscular layers are but little developed, and the flow of the secretion, set free by the dehiscence of the gland-cells, is produced partly by its own gradual accumulation, partly by the movements of the other organs. The tubes may appear white, yellow, brown, green, or red, according to the colour and quantity of their contents. Their size and number vary greatly, their length being, as a rule, inversely proportional to their number.

The Malpighian vessels are exclusively excretory (renal) organs, and not, as has been supposed, biliary, or both biliary and renal. This is supported by their mode of development as outgrowths of the hind-gut by their early origin, and by the fact that they are functional before any bile is found and while the hind-gut is still a blind pouch, but chiefly by their close resemblance to the urinary tubules of higher animals, and by the nature of their contents. It is well made out that they contain specific urine-constituents, such as uric acid, acid sodic and ammonic urates, leucin, calcic oxalate, &c., and that no substance not already known in the urine of other animals occurs in them.

The chief facts tending to support the theory that these tubes are hepatic as well as renal, are the yellow and green colours often observed in them, and the polymorphism of their epithelial cells. With regard to the first of these points, Schindler states that the colour is dependent on a specific colouring matter in the blood plasma, that no bile pigments are present, and that the colour is very inconstant. The polymorphism of the cells was used as an argument for double function by Leydig, who supposed that certain cells had assigned to them a hepatic, others a renal function. But according

* 'Zeitsch. f. wiss. Zool.,' vol. xxx. p. 587.

to Schindler there is no constancy in the occurrence of the different forms of cells, and moreover all of them contain the characteristic urinary concretions.

The urinary epithelium of insects contains none of the so-called *Dauer-zellen* or long-lived cells, but renewal of the cells takes place either by division, or (probably) by the nucleus of a cell which has undergone dehiscence, enlarging to form a new cell, its nucleolus becoming the nucleus of the latter.

Parasitic Crustacea.—M. Hesse gives the name of *Pachynesthus violaceus* and *Polyoon luteum* to two new parasitic crustaceans of microscopic dimensions (1–2 mm.), two females of which were discovered in the harbour at Brest, enclosed in the interior of a compound ascidian. The genera are new. M. Hesse remarks * in regard to their life-history:—

The completely stationary and so to speak secluded existence, to which these crustacea are condemned, does not require, as in the case of those which live in a free condition, perfect means of locomotion, for which they would have no use; those which they do possess are rather destined to serve for creeping than swimming.

Constantly shut up in an extremely limited enclosure formed of a more or less hard test of cellulose, they are obliged, in order to move in these narrow dwellings, to make themselves a passage by main force, and as Professor Giard has very well observed in his remarkable work on *Synascidia*, they are obliged to make galleries, by means of which they introduce themselves into the viscera; they penetrate into the ovaries, and produce such disorders as often cause the death of the whole colony, and might lead to the belief in the existence of a new species, although these modifications are only the result of the disturbances which they have produced in the individuals.

This work of burrowing, which I will compare to that of the mole cricket, results in the disappearance of the common cloacæ and their replacement by small openings very near together, the utility of which to these crustacea is easily conceived. Without these issues, in fact, the young embryos could not quit the enclosure nor disseminate themselves, and thus contribute to the dispersion of their species, and the males would be imprisoned and reduced to a state of captivity which is evidently contrary to the *rôle* which they have to fulfil, if I judge from crustacea closely allied to these, with which I am acquainted, and which are extremely agile and provided with all necessary means of swimming with facility.

Moreover, this liberty which the males enjoy easily explains their rarity, or rather the difficulty which there is in procuring them. They are rarely sedentary. It is of course on this account that they are more seldom met with than the females, which are condemned to live always in confinement. These latter are besides rather difficult to see, by reason of their extreme smallness; and if it were not for the eggs, which are generally of a very marked colour and which denote their presence, they would often not be seen.

The means of locomotion with which these crustacea are endowed

* 'Ann. des Sci. Nat. Zool.,' 6th ser., vol. vii. p. 7.

in order to surmount the obstacles which oppose their passage into the midst of the viscera of the Synascidians, consist of thoracic limbs, which are rather long and slender, and are terminated either by a single hooked claw, as in the *Polyoon*, or by several, as in the *Pachynesthus*. There may be further observed, in both, the cupulæ placed at the base of the legs from which they emerge, which, by their contractions and the ease with which they assume several shapes, can be applied like suckers to surfaces and be fixed there, or being lengthened into a point, they may serve as means of propulsion.

Finally, it is not uninteresting to observe the mode of termination of the abdominal extremity in these two crustacea.

In the one (*Pachynesthus*) it presents an appendage armed with two divergent points, in the form of a dovetail; underneath these are two other points directed perpendicularly, a combination which seems to me designed to draw up or drive away objects, as is done by the *boat-hook* employed by sailors for the same purpose.

Polyoon likewise has the extremity of the abdomen armed with two claws, which instead of being flat, are rounded, short, hooked, and terminated by a sharp point. They can also be raised, and then serve for propulsion, or be lowered, and on being drawn together, seize objects so as to draw them up and furnish a point of support for a retrograde movement.*

As to the alimentation of these animals, I am necessarily reduced to conjecture; but it does not seem to me possible that they should live otherwise than at the expense of their hosts, either on their material, their secretions, or their eggs.

The form of the mouth, which generally gives such valuable indications concerning its use, does not here lead to any definite conclusion, seeing that it can serve as well for suction as for mastication; we may therefore presume that it is employed for both purposes. It seems evident that it should be so, for without that the crustacea, who cannot seek their food outside, would infallibly perish if they did not find within their reach all that was necessary for them. (The species are figured.)

Improvements in Micro-photography.—Since the year 1844, when the first micro-photographic productions of Donné and Foucault appeared in the form of an atlas of microscopic anatomy, in which the plates were taken from daguerrotypes, histologists and microscopists have been unable to reconcile themselves to introducing photography generally as an integral part of microscopic research, in spite of the excellent publications of Gerlach and Benecke. Only in particular cases, when the inquirer was familiar with the application of photography to other purposes, has it been applied to produce pictorial representations of microscopic preparations. And yet the advantages which arise from such a method of delineating objects are beyond criticism and universally admitted.

The reason for this has been the complicated methods of preparing the sensitive plates. There was also required not only a micro-

* It is particularly remarkable that the greater number of parasitic crustacea which live in the interior of the ascidians, present similar dispositions.

photographic camera, which in one way or another had to be connected with the tube of the microscope, but also a small photographic atelier with a dark chamber. It required a certain time to learn how to prepare the plates, and many thought that they could only acquire skill in working from a course taken under a practical photographer.

The important advances in general photography have now been extended to the application of it to microscopical research, and endeavours have been made for some time to discover a process which will obviate the inconvenience of a photographic dark chamber and of having to prepare the plates each time, and which will allow of the sensitive plates being kept in stock, so that their complete sensitiveness is preserved for an indefinite time.

Of late years, the most various methods of preparing photographic dry plates have been proposed. The best, most tested, and surest process, however, is that of F. Wilde, of Görlitz, who has recently tested most carefully various approved forms of the dry process, and so improved it that anyone by keeping closely to the directions given with the plates, which can be obtained ready prepared, is in a position to produce excellent photographic pictures. A dozen prepared plates, each containing from 70 to 80 square centimetres of surface, cost six to seven shillings.

I * have occupied myself now for nearly twenty years in my leisure moments with the application of photography to subjects of natural history, either generally, or specially in microscopic work, and possess the requisite facility in all photographic manipulations. In spite of this, however, since I have become acquainted with Wilde's dry plates I have laid aside every other contrivance, and work only with that process. No method offers the same certainty, entails so little loss of time, and allows of such simple working, and I can therefore recommend it in the most pressing manner to my collaborators.

For the benefit of those who might wish to prepare the plates themselves, it may be stated that the sensitive covering consists of an emulsion of collodion, in which various salts of silver, chiefly bromide of silver, are suspended. Glass plates upon which a solution of 1 gramme of caoutchouc in 150 to 200 grammes of benzine has been poured, are covered with this emulsion, which, every time it is used, must be well shaken, and then allowed to rest again for some minutes. When the film has set a little the plates must be forthwith dried by the application of moderate heat, which may be done either in a small drying oven, or by moving them to and fro over a plate beneath which a spirit lamp is placed; after being dried, the plate is ready for use, either at once or at any subsequent time.

To use the plates all that is necessary is a conical tube for the end of the microscope, such as I have fully described in my work on 'Light as Employed in Scientific Research,' page 345, the wide end of which is placed uppermost. Connected with the tube is a cross piece on which the photographic cassette and the ground glass are placed. Such an apparatus, which can be got complete for about 20s., is quite sufficient to obtain the most beautiful micro-photographs

* Dr. S. Th. Stein, in 'Zeitschrift für Mikroskopie,' vol. i. p. 140.

by means of dry plates. If a considerable number of small cassettes are prepared, you can provide them with the dry plates in the evening, and the next day, as wanted, take micro-photographs. These, for which according to the intensity of the light one second up to several minutes are required, may be let stand till the evening if you are not in a position to darken your room, in order that you may at one and the same time develop and fix the pictures. The time required depends of course on the source of light. If direct sunlight is used with a low magnifying power, a perfect photograph may be produced in a fraction even of a second. With a magnifying power of 200 to 500 diameters, the time of exposure required with sunlight is from twenty-five seconds to half a minute, under some circumstances a whole minute. Bright daylight or sunlight reflected from a bright cloud requires even with low powers from a half to two and even three minutes. High powers cannot be used in diffused daylight. Magnesium light offers a good substitute, and by employing it with Wilde's dry plates superior "photograms" are obtained even with very high amplification. The time of exposure is in proportion to the intensity of the light. Magnesium light is about forty times weaker than sunlight, consequently the time of exposure required for a photograph with magnesium light is about forty times as long as with direct sunlight: for low powers therefore a period of about three-quarters of a minute, for high powers a period of from several minutes to a quarter of an hour. The latter period is requisite with the highest powers which as yet it has been possible to employ for photographic purposes.

The further development and fixing of the image is effected according to Wilde's directions in the following manner:—

First, over the plate which has received the impression there is poured, to develop it, a solution of

20 cubic centimetres alcohol,
5 „ „ distilled water,
10 drops of the solution B (below) of bromide of potash,

and it is left to the action of this mixture one to two minutes; then it is carefully rinsed with water till all greasy streaks have disappeared, and the water flows quite evenly over the plate.

In the development the following solutions are wanted:—

A. 5 grammes pyrogallic acid, 25 cubic centimetres alcohol, 25 cubic centimetres distilled water.
B. 5 grammes bromide of potash, 75 cub. centim. distilled water.
C. 3 grammes gelatine, 20 cub. centim. of acetic acid, 400 cub. centim. distilled water.
D. 25 grammes of carbonate of ammonia, 150 cub. centim. of distilled water.

Shortly before it is wanted for use a mixture is made of

40 drops of A.
20 „ B.
10–15 „ C.
15 cub. cm. D.

The latent image is washed over with this mixture and kept moist for several minutes by repeated washings.

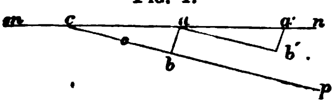
After the image, complete in all its details, has by this means been developed, it is washed by pouring water over it, and fixed by dipping it in a solution of hyposulphite of soda (1 to 10). It is again washed, dried, and varnished.

The process of taking prints is conducted in the same way as in ordinary photography; a very practical and simple method is that by means of sulphate of iron. A durable prepared paper may be obtained from Marion and Gévy, of Paris, which gives excellent copies in blue colour, without any special skill being required.

Measure for Covering Glass.—For the exact measurement of the thickness of covering glass to hundredths of a millimetre two different mechanical appliances have hitherto been employed—the screw and the lever. The editor of the 'Zeitschrift für Mikroskopie'* points out that the same object may be attained by a suitable adaptation of a movable wedge, the measuring wedge invented by P. Schönemann, which is distinguished by its great simplicity and solidity, and has recently been considerably improved.

The geometrical principle of the apparatus is as follows:—If a right-angled triangle $a\,b\,c$ (Fig. 1), whose hypothenuse $a\,c$ = 5 cm.,

FIG. 1.



and its perpendicular $a\,b$ = 1 cm., moves between the fixed lines $m\,n$ and $o\,p$ in such a way that $a\,c$ slides along $m\,n$; then the line $c\,b$ (1) always remains parallel to $o\,p$, (2) the distance between the movable line $c\,b$ and the fixed line $o\,p$ will always be one-fifth part of the distance which the point c, or any other point of the hypothenuse $a\,c$, has moved from its original position.

If, for instance, the triangle $a\,b\,c$ moves to $a\,a'\,b'$, the point c will have moved over the distance $a\,c$ = 5 cm., while the line $c\,b$ will have moved to the distance $a\,b$ = 1 cm. from the fixed line $o\,p$.

It is on this principle that the construction of Schönemann's gauge is based, as shown in Figs. 2 and 3.

FIG. 2.

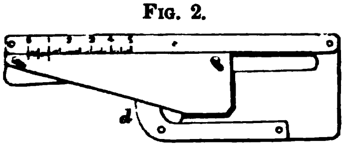
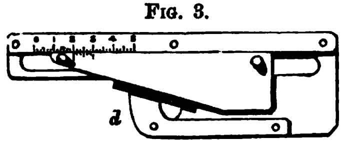


FIG. 3.



On one of the long sides of a brass base-plate a scale is fixed, the divisions on which are half a millimetre apart. On the other long side is a piece of brass bent inwards (d, Fig. 2). Between these a wedge, provided with a nonius, can be moved backwards and

* Vol. i. p. 283.

forwards by means of two buttons, and is prevented from falling out by proper guides in the slit of the base-plate.

When the long side of the wedge is contiguous to the edge of the beaked piece *d* (Fig. 2), the first line on the nonius coincides with the zero point of the scale.

To measure the thickness of a covering glass, the wedge is drawn back till the object to be measured can be placed on the edge of the piece *d* (Fig. 3). Then it is moved back again, pressing it slightly against the scale until a check is felt to the motion. The first line on the nonius will now no longer coincide with the zero point on the scale (Fig. 3). The number of divisions denoted by figures gives the whole millimetres, the number of smaller divisions the tenths of a millimetre, and the nonius the hundredths of a millimetre.

In using the instrument, care should be taken that it is free from dust, and that the motion of the wedge is easy.

By this instrument, when neatly and correctly made, the most exact measurements can be taken with a rapidity and ease that even a well-made screw micrometer will not admit of.

Origin of the Sexual Products in Hydroids.—J. Ciamician has made a series of careful observations * on the exact mode of origin of the ova and spermatozoa in two genera of *Hydroida*, and his results are altogether opposed to the theory of Van Beneden, according to which the ectoderm may be looked upon as the male, the endoderm as the female germ-lamella. In *Tubularia mesembryanthemum* the reproductive organs are sporosacs, and arise as bud-like processes composed of ectoderm and endoderm. The ectoderm at the distal end of this bud undergoes a process of invagination, and the bottom of the sac thus produced growing distalwards, forms from its endoderm the spadix of the sporosac, from its ectoderm the ova or sperm-mother-cells. The generative products of both sexes are therefore products of the ectoderm.

In *Eudendrium ramosum* the ectoderm on one side of the female generative bud undergoes proliferation, and pushes the endoderm towards the opposite wall: one of the ectodermal cells thus pushed in, enlarges greatly and produces an ovum, which is finally enclosed, by the completion of the process of virtual invagination, by a double layer of endoderm and a single one of ectoderm. So that in this case also, the ova are ectodermal products.

In the male gonophore of the same species, the case is quite different. Certain of the cells of the endoderm—the sperm-mother-cells—enlarge greatly, and their nuclei undergo extensive multiplication: as growth proceeds they become completely overarched by the neighbouring endoderm cells, and finally come to lie between the two layers, often having the appearance of belonging rather to ectoderm than to endoderm. Their contents become converted into spermatozoa, which are thus endodermal products.

There is, therefore, almost every possible variation in the origin of the generative products among the Hydrozoa; in *Tubularia* (Ciamician) and in *Hydra* (Kleinenberg), both male and female

* 'Zeitsch. f. wiss. Zool.,' vol. xxx. p. 501.

elements are ectodermal; in *Hydractinia* (Van Beneden) the ova are endodermal and the spermatozoa ectodermal; lastly, in *Eudendrium* (Ciamician) the ova are ectodermal and the spermatozoa endodermal.

Ciamician supposes that the generative products arose in the first instance indifferently from either layer, and that by further development they left their original position and came to lie between the two lamellæ.

Sir Joseph Hooker on the Modern Development of Micro-botany.—Sir Joseph Hooker devoted part of his address as President at the last anniversary meeting of the Royal Society to the modern development of botanical science, there being, as he pointed out, perhaps no branch of research with the early progress of which the Society was more intimately connected.

"One of our earliest secretaries, Robert Hooke, two centuries ago, laboured long and successfully in the improvement of the microscope as an implement of investigation. He was one of the first to reap the harvest of discovery in the new fields of knowledge to which it was the key, and if the results which he attained have rather the aimless air of spoils gathered hither and thither in a treasury, the very fulness of which was embarrassing, we must remember that we date the starting-point of modern histology from the account given by Hooke in his 'Micrographia' (1667) of the structure of cork, which had attracted his interest from the singularity of its physical properties. Hooke demonstrated its *cellular structure*, and by an interesting coincidence he was one of the first to investigate, at the request, indeed, of the founder of the Society, Charles II., the movement of the sensitive plant *Mimosa pudica*, one of a class of phenomena which is still occupying the attention of more than one of our Fellows. In attributing the loss of turgescence, which is the cause of the collapse of the petiole and subordinate portions of the compound leaf which it supports, to the escape of a subtle humour, he to some extent foreshadowed the modern view which attributes the collapse of the cells to the escape of water by some mechanism far from clearly understood—whether from the cell-cavities or from the cell-walls into the intercellular spaces.

Hooke having shown the way, Nehemiah Grew, who was also secretary of the Royal Society, and Marcello Malpighi, Professor of Medicine in the University of Bologna, were not slow to follow it. Almost simultaneously (1671–3) the researches of these two indefatigable students were presented to the Royal Society, and the publication of two editions of Malpighi's works in London prove how entirely this country was at that time regarded as the head-quarters of this branch of scientific inquiry. We owe to them the generalization of the cellular structure, which Hooke had ascertained in cork, for all other vegetable tissues. They described also accurately a host of microscopic structures then made known for the first time. Thus, to give one example, Grew figured and described in several different plants the stomata of the epidermis:—'Passports either for the better avolation of superfluous sap, or the admission of air.'

With the exception of Leeuwenhoek, no observer attempted to

make any substantial addition to the labours of Grew and Malpighi for more than a century and a half, and however remarkable is the impulse which he gave to morphological studies, the views of Caspar Wolff in the middle of the eighteenth century (1759), in regarding cells as the result of the action of an organizing power upon a matrix, and not as themselves influencing organization, were adverse to the progress of histology. It is from Schleiden (1838), who described the cell as the true unit of vegetable structure, and Schwann, who extended this view to all organisms whether plants or animals, and gave its modern basis to biology by reasserting the unity of organization throughout animated nature, that we must date the modern achievements of histological science. Seldom, perhaps, in the history of science has any one man been allowed to see so magnificent a development of his ideas in the space of his own lifetime as has slowly grown up before the eyes of the venerable Schwann, and it was therefore with peculiar pleasure that a letter of congratulation was entrusted by the officers to one of the Fellows of this Society on its behalf on the recent occasion of the celebration of the fortieth anniversary of Schwann's entry into the professoriate.

If we can call up in our mind's eye some vegetable organism and briefly reflect on its construction, we see that we may fix on three great steps in the analysis of its structure, the organic, the microscopic, and the molecular, and, although not in the same order, each of the three last centuries is identified with one of these. In the seventeenth century Grew achieved the microscopic analysis of plant tissues into their constituent cells; in the eighteenth, Caspar Wolff effected the organic analysis (independently but long subsequently ex pounded by the poet Goethe) of plant structures into stem and leaf. It remained for Nägeli in the present century to first lift the veil from the mysterious processes of plant growth, and by his memorable theory of the molecular constitution of the starch-grain and cell-wall, and their growth by intus-susception (1858), to bring a large class of vital phenomena within the limits of physical interpretation. Strasburger has lately (1876) followed Sachs in extending Nägeli's views to the constitution of protoplasm itself, and there is now reason to believe that the ultimate structure of plants consists universally of solid molecules (not however, identical with chemical molecules) surrounded with areas of water which may be extended or diminished. While the molecules of all the inert parts of plants (starch-grains, cell-wall, &c.) are on optical grounds believed to have a definite crystalline character, no such conclusion can be arrived at with respect to the molecules of protoplasm. In these molecules the characteristic properties of the protoplasm reside, and are more marked in the aggregate mass in proportion to its denseness, and this is due to the close approximation of the molecules and the tenuity of their watery envelopes. The more voluminous the envelopes, the more the properties of protoplasm merge in those of all other fluids.

It is, however, to the study of the nuclei of cells that attention has been recently paid with the most interesting results. These well-known structures, first observed by Ferdinand Bauer at the

beginning of the century (1802), were only accurately described, thirty years later, by Robert Brown (1833). Up to the present time their function has been extremely obscure. The beautiful investigations of Strasburger (1875) have led him to the conclusion that the nucleus is the seat of a central force which has a kind of polarizing influence upon the protoplasm molecules, causing them to arrange themselves in lines radiating outwards. Cell-division he regards as primarily caused by the nucleus becoming bipolar, and the so-called caryolitic figures first described by Auerbach exhibit the same arrangement of the protoplasm molecules in connecting curves as in the case of iron-filings about the two poles of a bar-magnet. The two new centres mutually retire, and each influencing its own tract of protoplasm, the cell-division is thereby ultimately effected. This is but a brief account of processes which are greatly complicated in actual detail, and of which it must be remarked that, while the interest and beauty of the researches are beyond question, caution must be exercised in receiving the mechanical speculations by which Strasburger attempts to explain them. He has himself shown that cell-division presents the same phenomena in the animal kingdom, a result which has been confirmed by numerous observers, amongst whom I may content myself with mentioning one of our own number, Mr. F. Balfour. Strasburger further points out that this affords an argument for the community of descent in animal and vegetable cells; he regards free cell-division as derivable from ordinary cell-division by the suppression of certain stages."

The address then deals with the discoveries made during the last five years in physiological botany, more particularly by Mr. Darwin and Dr. Burdon Sanderson.

Lichens, Bacteria, Bacillus Organisms, and the Lowest Forms of Life.—Referring to these subjects, Sir Joseph Hooker said, "In morphological botany attention has been especially directed of late to the complete life-history of the lower order of cryptogams, since this is seen to be more and more an indispensable preliminary to any attempt at their correct classification.

The remarkable theory of Schwendener, now ten years old, astonished botanists by boldly sweeping away the claims to autonomous recognition of a whole group of highly characteristic organisms—the lichens—and by affirming that these consist of ascomycetal fungi united in a commensal existence with algæ. The controversial literature and renewed investigations which this theory has given rise to is now very considerable. But the advocates of the Schwendenerian view have gradually won their ground, and the success which has attended the experiments of Stahl in taking up the challenge of Schwendener's opponents, and manufacturing such lichens as *Endocarpon* and *Thelidium*, by the juxtaposition of the appropriate algæ and fungi, may almost be regarded as deciding the question. Sachs, in the last edition of his 'Lehrbuch,' has carried out completely the principle of classification of algæ, first suggested by Cohn, and has proposed one for the remaining thallophytes, which disregards their division into fungi and algæ. He looks upon the

former as standing in the same relation to the latter as the so-called saprophytes (e.g. *Neottia*) do to ordinary green flowering plants.

This view has especial interest with regard to the minute organisms known as *Bacteria*, a knowledge of the life-history of which is of the greatest importance, having regard to the changes which they effect in all lifeless and, probably, in all living matter prone to decomposition. This affords a morphological argument (as far as it goes) against the doctrine of spontaneous generation, since it seems extremely probable that just as yeast may be a degraded form of some higher fungus, *Bacteria* may be degraded allies of the *Oscillatoriæ*, which have adopted a purely saprophytal mode of existence.

Your 'Proceedings' for the present year contain several important contributions to our knowledge of the lowest forms of life. The Rev. W. H. Dallinger, continuing those researches which his skill in using the highest microscopic powers and his ingenuity in devising experimental methods have rendered so fruitful, has adduced evidence which seems to leave no doubt that the spores or germs of the monad which he has described differ in a remarkable manner from the young or adult monads in their power of resisting heated fluids. The young and adult monads, in fact, were always killed by five minutes' exposure to a temperature of 142° F. (61° C.), while the spores germinated after being subjected to a temperature of 10° above the boiling-point of water (222° F.).

Two years ago, Cohn and Koch observed the development of spores within the rods of *Bacillus subtilis* and *B. anthracis*. These observations have been confirmed, with important additions, in these two species by Mr. Ewart, and have been extended to the *Bacillus* of the infectious pneumo-enteritis of the pig, by Dr. Klein; and to *Spirillum* by Messrs. Geddes and Ewart; and thus a very important step has been made towards the completion of our knowledge of the life-history of the minute but important organisms. Dr. Klein has shown that the infectious pneumo-enteritis, or typhoid fever of the pig, is, like splenic fever, due to a *Bacillus*. Having succeeded in cultivating this *Bacillus* in such a manner as to raise crops free from all other organisms, Dr. Klein inoculated healthy pigs with the fluid containing the *Bacilli*, and found that the disease in due time arose and followed its ordinary course. It is now, therefore, distinctly proved that two diseases of the higher animals, namely, 'splenic fever' and 'infectious pneumo-enteritis,' are generated by a *contagium vivum*.

Finally, Messrs. Downes and Blunt have commenced an inquiry into the influence of light upon *Bacteria* and other fungi, which promises to yield results of great interest, the general tendency of these investigations leaning towards the conclusion that exposure to strong solar light checks and even arrests the development of such organisms.

The practical utility of investigations relating to *Bacillus* organisms as affording to the pathologist a valuable means of associating by community of origin various diseases of apparently different

character, is exemplified in the 'Loodiana fever,' which has been so fatal to horses in the East. The dried blood of horses that had died of this disease in India has been recently sent to the Brown Institution, and there afforded seed from which a crop of *Bacillus anthracis* has been grown, which justified its distant pathological origin by reproducing the disease in other animals. Other equally interesting experiments have been made at the same Institution, showing that the 'grains' which are so largely used as food for cattle, afford a soil which is peculiarly favourable for the development and growth of the spore filaments of *Bacillus;* and that by such 'grains' when inspected, the anthrax fever can be produced at will, under conditions so simple, that they must often arise accidentally. The bearing of this fact on a recent instance in which anthrax suddenly broke out in a previously uninfected district, destroying a large number of animals, all of which had been fed with grains obtained from a particular brewery, need scarcely be indicated." *

Method of representing an Object from Microscopic Sections.—Whilst working on the central nerve system of the crayfish, Herr Krieger, of Leipzig, adopted the following method of obtaining as clear a view as possible of the internal structure.

The ganglia, after being hardened and stained, were imbedded in paraffin, and cut by the microtome into a series of transverse sections. For every section the position of the object-slider was read off on the scale of the microtome. When a satisfactory series of sections had been made, they were drawn with a camera, and the different tissue-elements (ganglia-cells, nerve-fibres, &c.) were marked out with different colours. Then a millimetre scale was drawn with the same amplification, and a sheet of paper ruled with parallel lines whose distance apart, according to this scale, was equal to the thickness of the sections. Each of the drawings was then orthographically projected on to a straight line drawn parallel to the transverse axis of the section, and, when the direction of the cut was exactly at right angles to the longitudinal axis of the object, each projection, according to its place as determined by the readings of the microtome scale, was marked off between the parallel lines in such a manner that the middle points of the projection (symmetrical on both sides) fell on a straight line drawn at right angles to the parallel lines. Nothing more has now to be done but to connect together the points of the projections corresponding to the outlines of the various structures, and by slight shading, &c., to distinguish between those lying higher or deeper, in order to get a representation of what the object would look like if it were perfectly transparent and were viewed from above. If the direction of the cut is not exactly at right angles to the longitudinal axis of the object, we must determine, by comparing the unsymmetrical halves of the section with those of the preceding and following ones, the angle of the symmetrical plane to that of the direction of the cut—draw the central line so that it forms this angle with the parallel lines, and mark off the projections as before.

* 'Proc. Roy. Soc.,' vol. xxviii. p. 43.

By horizontal and sagittal sections, as also by measurements of the drawing and the uncut object, the results obtained may be checked.

Though this plan may seem somewhat tedious, the author says that the result repays the trouble, as so plain a view of the object examined could not easily be obtained in any other way.*

Microscopy at the Paris Exhibition.—It seems to be agreed by those who visited this Exhibition that there was literally nothing new or calling for special remark either in Microscopes or accessories. Microscopes were included in Class 15, "Instruments of Precision," whilst Class 8, "Methods and Material of Higher Education," contained most of the Microscopic preparations exhibited, some of which were also included in Class 14, "Medicine, Hygiene and Public Assistance;" Class 12, "Photographic Apparatus and Photographs," contained Micro-photographs. The jurors in Class 15 were Lord Lindsay (for England), MM. Bardoux, Cornu and Laussedat, and Commandants Mouchez and Perrier (for France); Dr. Fleischl (for Austria-Hungary); Signor Colombo (for Italy); M. Broch (for Sweden and Norway); and M. Soret (for Switzerland).

We have endeavoured to compile a list of the gold, silver, and bronze medals and honourable mentions awarded to opticians and others for Microscopes, &c.; but as these were not separately classed, it is impossible to distinguish with complete accuracy the cases in which the award was made for Microscopes, or for some of the other instruments exhibited in conjunction with them. The difficulty would obviously not be solved by taking the names of those opticians who are makers of Microscopes only, and under these circumstances we must leave the official list to speak for itself.

The Generation of Gas in the Protoplasm of living Protozoa.—The discovery that gas is generated in the protoplasm of *Arcella* under the influence of volition, and serving for a hydrostatic purpose,† gave rise to the conjecture that other Protozoa living free in water might be able to make use of this simple means of vertical motion. Professor T. W. Engelmann says ‡ that his occasional attempts to confirm this supposition have led to a positive result in at least two instances.

He found on the surface of some water which was taken from a ditch richly covered with duckweed, a spherical *Sphærophrya*, measuring ·08 mm. which contained a large air-bubble. The species was distinguished by its size, and also by thirty to forty relatively very long (·12 mm.) and thin suctorial filaments regularly spread over the surface of the body; and also by numerous small contractile vesicles placed at some distance under the cuticle. It may be called *Sph. hydrostatica*. When the animal came to be examined, the air-bubble occupied about the fourth part of the volume of the body, it was situated immediately under the cuticle, and had in a tangential direction a long oval shape. In four minutes it disappeared, decreasing very gradually, and at the same time becoming

* 'Zoologischer Anzeiger,' vol. i. p. 369.
† See Pflüger's 'Archiv für die ges. Physiologie,' vol. ii.
‡ 'Zoologischer Anzeiger,' vol. i. p. 152.

more irregular and angular. The protoplasm meantime advanced from within towards the cuticle, which sank in somewhat and became folded. The original spherical form of the animal became very sensibly flattened. Attempts to produce a fresh generation of gas unfortunately could not be made.

The second case relates to a form allied to, if not identical with *Amœba radiosa.* It was obtained by a pipette from the surface of some water pretty thickly covered with *Lemna.* Amongst several specimens one was found which measured about ·15 mm., and was furnished with about twenty short, irregular, and pretty broad conical protuberances, which in the interior contained a perfectly spherical air-bubble about ·05 mm. in diameter. This continually diminished from the moment the animal came to be examined. Within three minutes it had disappeared, and he did not succeed in observing a new generation of air.

Since, therefore, the presence of gas-bubbles in living protoplasm has been confirmed in three forms of Protozoa lying widely apart from each other, it may be considered probable that the phenomenon is still further extended; but as he is only seldom in a position to pay attention to the subject, Professor Engelmann asks those of his fellow explorers in the same field, who have more frequent opportunities, to investigate the matter. Success would doubtless be best attained if the animals are taken from the surface of the water and examined as quickly as possible.

On this communication Professor Géza Entz, of Hungary, writes:*—"Referring to the account given by Professor Engelmann of the interesting phenomenon of gas-bubbles in the protoplasm of Protozoa swimming on the surface of water, I have had an opportunity of observing it, not only in *Arcella* and *Amœba*, in which (especially the former) it occurs with great frequency, but several times in *Difflugia proteiformis* also. The latter had always only one, but that a very large gas-bubble, occupying almost half the body; it gradually diminished whilst under examination, finally disappearing without leaving any trace: the *Arcella* and *Amœba*, on the other hand, often had several bubbles. Once I observed in an *Arcella* a bubble between the shell and the body of the rhizopod, which forced itself to the mouth of the shell and finally out from beneath it, like an air-bubble out of a submerged tilted bell. It should be observed that the generation of gas in the protoplasm of *Amœba* and *Arcella* was observed thirty years ago by Maximilian Perty, who gave the same explanation of the phenomenon as Engelmann."

Sperm-formation in Spongilla.—The presence of corpuscles of a zoospermatic nature in *Spongilla* appeared, says Dr. G. Keller,† from Lieberkühn's researches in 1856 to establish as an assured fact the existence of a sexual differentiation in the sponges. Since then, however, the investigation of marine sponges has so seldom succeeded in showing the spermatic elements, that recently serious doubts have been raised in influential quarters as to the sexual differentiation—

* 'Zoologischer Anzeiger,' vol. i. p. 248. † Ibid., p. 314.

doubts which must certainly now be considered completely disposed of after the proof of the separation of the sexes in *Halisarca* and in *Aplysilla sulfurea*, where, according to F. E. Schulze's investigations, male and female elements occur. Further observations may serve to give greater weight to Schulze's statement.

Dr. Keller endeavoured last year to examine the facts in question in *Spongilla*. A separation of the sexes seems to occur in this fresh-water sponge also—at least, he found all through the summer small specimens which contained neither eggs nor larvæ, but, on the contrary, were closely filled, especially in the spring, with sperm-follicles in the most varied stages of development. The smaller specimens were attached to the cases of the larvæ of *Phryganea*, and in these were found almost invariably sperm-balls. It is just these which must be especially adapted for fecundation.

The spermatic elements are enclosed in a special receptacle, and when mature move about in it with great activity.

Each follicle is surrounded by numerous cells (nutritive migratory cells). If a mature follicle bursts, or if it is made to burst by pressure on the covering glass, the sperm-cells disperse, and move about in large numbers (their heads disposed towards each other) for hours at a time with great briskness.

In the younger follicles the movement is wanting; the contents are numerous closely-pressed round elements. It is to be assumed in the case of *Spongilla*, therefore, that the sperm-follicle with its contents originates from a single cell by continual division.

These are recommended as a desirable object for demonstration in a course of zootomy, as the movements in the follicles last a considerable time. The small *Spongilla* found attached to the cases of *Phryganea* in May and June are the best adapted for this purpose.

The exact Orientation of the principal Section of Nicols in Polarizing Apparatus.—It is sometimes necessary to be able to determine the orientation of the principal section of the polarizers and analyzers—Nicols, double refracting prisms, &c.

It may be done simply and with precision by illuminating the apparatus, in order to adjust it, with yellow light, and interposing a diaphragm between the polarizer and analyzer, one-half of it being covered with a half undulation plate of thin quartz parallel to the axis.

This diaphragm can always be put in position. Polarizing apparatus generally have either a system of lenses or a single lens, which can then be used to view the diaphragm. If this is not the case, a small auxiliary lens can be used. The interior margin of the plate separates the two half-disks, and produces a well-defined line.

Let us suppose that it is required to fix a Nicol so that its principal section shall make a given angle with certain reticular threads, &c. The problem is reduced to placing the margin of the plate in the desired position, and, as this is a well-defined line, the optical and mechanical means are not wanting.

The Nicols are then adjusted with respect to the plate. To do this, the polarizer is placed so that its section is *approximately* in the

required direction, and the analyzer is turned a few degrees to the right and left. Two cases then present themselves:—

1. If this section is *by accident* exactly in the required position, the transition from partial to total extinction will be gradual, and no difference in intensity will be perceived between either of the two half-disks in any position of the analyzer.

2. If the section of the polarizer is not exactly in position, if it makes even an excessively small angle with the line of separation, variable differences will be found between the two half-disks.

If the analyzer is stopped in a position near to total extinction, one half-disk will be seen to be darker than the other; the polarizer should then be turned gradually till equality in tint is established, and that will be the position sought. This should be tested by turning the analyzer, when the two half-disks ought to be found perfectly equal in intensity, this intensity varying with the rotation of the analyzer.

The position of the polarizer is marked; then to determine that of the section of the analyzer the polarizer is gently displaced about $1\frac{1}{2}°$, which destroys the equality of the intensities; this is afterwards restored by the analyzer. The principal section of the latter will be found at exactly 90° from this last position.

This method can also be used to determine the principal sections of quarter and half undulation plates, and that of plates parallel with the axis. It gives much greater precision than the ordinary methods.

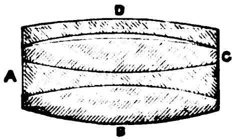
The margin of the half-plate, which separates the two half-disks, is perfectly clear, and without thickness; we have then to compare two surfaces of different intensities which are *strictly tangent*. If the adjustment is made with care, the slightest difference will be appreciable; and this detail contributes much to increase the precision of the method.*

Improvements in Object-glasses.—Mr. Gundlach, of Rochester, New York, has patented a method of constructing object-glasses for astronomical telescopes and other purposes, by which both aberrations are corrected to a higher degree than has hitherto been attained. The common double objective, consisting of a negative flint-glass lens and positive crown-glass lens, is deficient by reason of chromatic over-correction at the outer edge, and chromatic under-correction towards the centre. This is caused by the flint-glass lens, as usually shaped, not having the proper form to remove this defect. Nor can it be perfectly removed by any alteration in shape, except at the expense of increased spherical aberration, the correction of both aberrations depending on the same factor (the flint-glass lens), and on opposite conditions of this factor, the best form for the complete correction of the one producing the maximum of the other aberration.

The difficulty is obviated by constructing an object-glass, in which both the chromatic and the spherical aberrations are corrected by special means independent of each other, leaving the flint-glass lens to perform exclusively its legitimate function of correcting the

* M. L. Laurent, in 'Comptes Rendus,' vol. lxxxvi. p. 662.

chromatic aberration without reference to the spherical aberration, and correcting the latter by one or more negative crown-glass lenses of the proper focal relations to the others. The accompanying drawing represents a cross section of the object-glass. A is the double concave flint-glass lens; B and C crown-glass lenses, of appropriate focal proportions; and D an additional negative crown-glass lens, its purpose being the completest correction possible of the spherical aberration. The double concave form is the best for the highest possible correction of the chromatic aberration, the ordinary concavo-convex form having been adopted only as a compromise aiming at the correction of both aberrations at the same time, which can only be imperfectly attained under such circumstances. By this means the objective can be made almost absolutely achromatic, leaving the spherical aberration to be corrected by other and independent means, viz. by the special negative crown-glass lens, D (or, if preferred, more than one), concavo-convex in shape, the concave surface of which has a shorter radius than the convex surface of the positive crown-glass lens next to it, so that between the two a space remains in the shape of a meniscus.



The loss of illuminating power on account of the increased number of surfaces can be reduced to a minimum by cementing the adjoining surfaces; the loss being further reduced in comparison with a double object-glass by having the outer surfaces consisting of crown glass, the loss of light on such surfaces being less than on flint-glass surfaces. It will, moreover, be preponderatingly compensated by the better correction of the aberrations and the greater clearness and sharpness of definition resulting therefrom.

British Acari—Oribatidæ.—Mr. A. D. Michael has sent a paper to the Society (which cannot be published yet for want of space) giving the results of his researches among British *Acari* of the family *Oribatidæ*, conducted during the past year in conjunction with Mr. C. F. George. Forty-four species have been found, of which only three or four have been previously recorded as British. Of these forty-four species, three are believed to be entirely new, viz. two species of the genus *Tegeocranus* which Mr. Michael proposes to call respectively *T. labyrinthicus* and *T. elongatus*, and one which he proposes to make the type of a new genus to be called *Scutovertex*, the species being called *sculptus*. The new species are fully described and figured. The life-history of *Tegeocranus latus*, *Nothrus theleproctus*, &c., of which the larvæ and nymphs were not previously known, have been traced, and are described and figured.

The Structure of the Nerves in the Invertebrata.—The histological characters of the nerves, whilst determined with precision for the Vertebrata, are imperfectly known in the other divisions of the animal kingdom. Their exact determination is nevertheless important from all points of view, for the examination of the external form alone is insufficient when we wish to know if such or such part among inferior

animals, among the *Radiata* particularly, belongs or not to the nervous system. Certain authors, moreover, have taken their stand on the differences which the nerve elements present in Invertebrata and Vertebrata to mark further the separation which exists between these two divisions of animals.

The nerves of Decapod and other Crustacea, in spite of their bulk, are difficult to study, by reason of the rapidity with which these elements alter when they are isolated or dead, or are brought into contact with any reagent. The nerves of the ganglionic chain and the peripheral nerves present identical characters. They are formed by bundles of nerve-tubes enveloped in a sheath of very thick perineurine.

Each of these tubes is composed of a *sheath* of a homogeneous amorphous substance, the contents of which are soft, easily changeable, sometimes homogeneous, sometimes either finely granular, or striated longitudinally. These tubes are very voluminous. Their diameter varies from ·01 mm. to ·08 mm. and ·09 mm. Notwithstanding that, all the cylinder of the substance or soft fibre which fills the amorphous sheath of the nerve-tubes of the Crustacea corresponds to the single *cylinder-axis* of the nerve-tubes of the Vertebrata, an idea already propounded, but in a rather doubtful manner, by Leydig. The myeline is wanting, and its absence leaves the essential microscopical filaments of the nerves with their transparency and their paleness, whence the difficulty of seeing them by transmitted light as with the naked eye. Our * researches show that there is identity of substance between the cellular body of the ganglionic cells and the contents of the nerve-tube starting from the ganglia. 1st, the large cells of the ganglia which attain the size of one-fifth to one-fourth of a millimetre, have prolongations very nearly as large as the largest peripheral nerve-tubes into which we succeeded in following them, as so many fibres filling the tube or homogeneous sheath; 2nd, immediately after death sarcodic atoms are formed in the cells and in the substance of the nerve-fibres, gradually bringing about the decomposition of both into granular masses of identical appearance; 3rd, nitric acid, alum, and perchloride of iron produce at the same time coagulation of the body of the cells and the contents of the tubes. Nitric acid, particularly, gives an absolutely conclusive reaction; it retracts the substance of the nerve-fibres, and produces a very distinct and regular longitudinal striation; the same striation is seen on the cells and their immediate prolongations.†

* M. Cadiat, in 'Comptes Rendus,' vol. lxxxvi. p. 1420.

† This is difficult to demonstrate among the Vertebrata; and it has been sought for in many ways, because it is important to physiology to know if each cylinder-axis is a bundle of nervous conductors. In the Crustacea, particularly in the *Maia squinado*, this situation is very evident. On the ganglionic chain of larva of *Libellula* are found nerve-tubes identical with those of the Crustacea. But, in the insects, the sheaths of Schwann are very fine and fragile, and under the influence of the least pressure or of a liquid having sufficient osmotic power, all the tubes enclosed in the same sheath of perineurine break and leave a granular residue scattered over with nuclei. This granular matter, under the influence of alum and carmine, takes exactly the same tint and the same appearance as the masses which surround the nucleus of the nerve-cells. In the Leech, Dytiscus, and Hydrophilus we have obtained analogous results.

To sum up; among the Crustacea, the Insecta, and the Annelida, the structure of the nerves differs from that of the Vertebrata by the complete absence of the substance endowed with great refractive power, called *myeline*, which in these latter is interposed between the cylinder-axis and the proper wall of the tube, the grey fibres of the great Sympathetic excepted.

In the Gasteropodous and Acephalous Molluscs the nerves are further simplified; the sheath proper, or sheath of Schwann, is wanting in almost all the nerves. The *nerve-tubes* only, represented by the *cylinder-axis*, form bundles which it is difficult to dissociate.

One more character remains yet to be added to those which we have referred to. The nerve-cells of Crustacea were of an extreme fragility. The contents of their tube are displaced very easily. In the snail the cell takes a certain consistency. The cylinder-axis of the nerves opposes also more resistance to pressure and to chemical agents.

The author adds in a further foot-note:—In the Bryozoa we have observed a nerve layer situated under the ectoderm. This layer was composed of cells very distant from one another, and united by bundles of rectilinear filaments possessing small oval nuclei in their thick part, resembling those which are formed in the nerve-fibres during development in all animals. From this sort of plexus start very fine threads which extend along the tentacles, others go to the retractor muscle. The characters observed in the nerve-tubes of all the animals which we have passed in review allow us to conclude that the cells with the filaments which depend from them, and which we have seen in the Bryozoa, are truly nerve elements. Here, the nerves, closely allied in their structure to those of the Molluscs properly so called, would be reduced to the *cylinder-axis*.

Development of Cephalodia on Lichens.—M. Babikof has undertaken some investigations with the view of settling the origin of the peculiar excrescences found on the surface of some lichens, known as *Cephalodia*. The result is contained in a paper* presented to the Imperial Academy of Sciences of St. Petersburg.

The author says that the structure of the cephalodia is known in a small number of lichens only, and that there are but few exact notions as to their development-history. Some hypotheses, very probably correct, have been suggested, but they have not yet been established by facts. A summary is given of the views of Messrs. Nylander, Th. Fries, Schwendener, and Bornet, on the cephalodia of *Stereocaulon*, and it is pointed out that what they have observed has been simply different degrees of development of the alga by the hypha, and not the complete progress of the development of the cephalodia.

"It is therefore only in consequence of simple isolated facts that the authors have supposed that the cephalodia are abnormal formations produced by a local growth of the lichen under the influence of algæ accidentally fallen upon it. Their hypothesis has, however, been completely confirmed by experiments which I have made under the guidance of Professor A. S. Famintzin, on the development of the

* 'Bull. de l'Académie des Sciences de St. Petersburg,' vol. xxiv. p. 548.

cephalodia of *Peltigera aphthosa*, which I have followed from the first commencement of the invasion of the alga by the hypha up to the complete development of the cephalodia."

After a reference to the description given by Acharius of the cephalodia in question, the author thus details his own investigations.

In vertical sections of a cephalodium of *Peltigera aphthosa* completely developed, the central part consisted of a tissue of filaments loosely interlaced with hypha, between which were masses of bluish gonidia, arranged without any apparent order, whilst the periphery was formed of a homogeneous brown cortical layer, much thicker on the superior side than on the inferior, and consisting of pseudo-parenchymatous tissue. From the inferior surface descend a row of radical hairs (rhizines) of a dark brown, of which the membranes, very much thickened, penetrate to the soil through the openings of the thallus of *Peltigera* and interlace themselves with the similar hairs of the latter. The body itself of the cephalodium is in contact with the edges of the opening of the thallus, like a cover, and without any organic relationship with it. If the general form of the cephalodium were examined, without knowing the history of its development, we should suppose that it must be a homeomerous lichen growing parasitically on the *Peltigera* and bearing a resemblance to *Pannaria triptophylla*, for example. The gonidia of the cephalodia are blue, and consequently belong to the phycochromaceous algæ; whilst those of the lichen itself are of a light green and belong to the chlorophylaceous. They are also distinguished from one another by their size; the former attain ·010 mm., the latter only ·006 mm. Both are oblong, often triangular or square, but rarely round. In examining the form of the gonidia of the cephalodia it is impossible to decide to what algæ they belong.

To solve this question, the author took advantage of the method of culture employed by MM. Famintzin and Baranetsky, in their researches on the gonidia of *Collema pulposum* and *Peltigera canina*, and sowed in soil previously boiled some sections of cephalodia (examined under the microscope to assure the absence of any foreign organism), and then placed under a bell-glass in a damp atmosphere. At the end of two weeks and a half, when the hyphæ were entirely destroyed, there could be remarked on the surface of the sections a great number of small gelatinous balls, each containing three or four bluish cells. After another week the little balls acquired more considerable dimensions, and the number of bluish cells increased; at the same time these latter were found arranged in small doubled up chains, of which some already contained heterocysts characteristic of *Nostoc*. Five weeks after the sowing colonies of perfectly formed *Nostoc* were found, which consisted of numerous little chains, with completely developed heterocysts; the little chains were imbedded in a mucilage bounded by very distinct outlines. The cultivation of the gonidia proved therefore that they originated from the *Nostoc*, entirely changed in form under the influence of the invasion of the hypha.

Being desirous of knowing in what manner perfectly free *Nostoc*

had degenerated into gonidia and had given rise to the formation of the cephalodia, the author examined the history of the development of the latter with the following results:—

On the surface of the thallus of *Peltigera aphthosa* are found verrucose cephalodia, which, as they approach the edge of the lichen, become smaller and at last appear to the naked eye like a grain of dust. The smallest are the youngest. Amongst these excrescences is often found a bluish coating, which consists exclusively of *Nostoc* in different degrees of development; they are rarely found mixed with other algæ. By making transverse sections of the youngest portions of a perfectly fresh lichen, it may be seen under a high magnifying power that its surface is covered with a great number of hairs, formed of one, two, or three cells; among these hairs are often found whole colonies of *Nostoc*, some of which are entirely free, simply in contact with the surface of the hairs, and easily separating from them under the pressure of the covering glass; others, on the contrary, are so closely attached to the hairs, that it is only by very strong pressure that they can be detached, and then only by removing the hair at the same time. The hairs connected in this manner with the colonies, undergo a division into numerous cells, and put out little branches which penetrate into the interior of the mucilage and wind about among the filaments of the isolated *Nostoc*. This is the beginning of the formation of the cephalodia. In the same sections, or in others made on older portions of the lichen, colonies of *Nostoc* are met with where the interlacing by the hypha begins. We see distinctly that some of the branches insinuate themselves into the interior of the mucilage, whilst others only touch the surface and give rise to the cortical layer by forming numerous lateral branches which adhere to one another. At this period the cortical layer does not cover the whole surface of the colony; the mucilaginous substance, which has become darker, is seen projecting here and there, and in the interior the cells of *Nostoc* spread themselves, no longer arranged in the form of isolated filaments, but united into a compact mass. If this preparation is broken up, there will be seen, amongst the cells of *Nostoc*, filaments of hypha which start from the cells of the cortical layer. In sections made on an older portion of the lichen, colonies of *Nostoc* are found entirely interlaced by hypha, where the cortex is formed of a continuous layer of cells, arising from the ramification and their reciprocal adherence. At the first glance such formations might be taken for the fructifications of *Pyrenomycetes*, if the history of their development, as well as their anatomical structure, were not already known.

In proportion as the invasion of the *Nostoc* by the hypha becomes complete, the cells of the cortical layer of the lichen and the hyphæ of the gonidial layer rise considerably in their growth, and gradually form with the cephalodium a continuous tissue. The gonidia of the lichen, which are found below the cephalodium, perish and disappear gradually, being absorbed by the surrounding tissue; moreover they are no longer arranged in a continuous layer, but an intermittent one. In its more advanced stage, the cephalodium increases considerably in a direction parallel to the surface of the lichen and takes a lenticular

form. It is in this stage that it is described and figured by Acharius (t. x. f. 8). When the cephalodium so increases, the tissue of the lichen under it no longer appears in the form of pseudoparenchymatous cortex, and no longer encloses gonidia, but consists only of hyphæ very much interlaced, and it is only on the parts placed near the borders of the cephalodium, that there can still be observed a progressive transition of the round cells of the cortex into the completely developed filaments of the hypha, which degenerate progressively into radical hairs (rhizines) of a dark brown colour. As soon as the final transformation of the tissue of the bark of the lichen into filaments of hypha is accomplished, all connection between the cephalodium and the thallus of the lichen disappears. At the point where the separation of the cephalodium has taken place, the cells of the cortical layer of the lichen assume a brown hue; below them extends a layer of gonidia which, whilst it touches some of the radical hairs of the cephalodium, has no longer any connection with them. Under the layer of the gonidia of the thallus is arranged the medullary layer, whose filaments are clearly distinguished from the radical hairs by their more transparent colour, as well as by the thickness of their membrane. The cells of the hypha of the cephalodium, disposed under its gonidia, having degenerated into radical hairs, are transformed into pseudoparenchymatous cortex which covers its inferior face. As soon as the cephalodium becomes entirely independent of the lichen, it grows more and more horizontally, and finally receives the oblong, or orbicular and flattened form.

We may conclude that the cephalodia owe their origin to the parasitic nature of *Nostoc*, which is always found in damp places, where the lichen is usually met with. Not that the *Nostoc* alone takes part in the formation; other algæ also share in it perhaps, as Schwendener and Bornet have shown in *Stereocaulon*. It is possible, that if *Peltigera aphthosa* were gathered in some other locality, other algæ than *Nostoc* might perhaps also be found. A coloured plate of nine figures accompanies the paper.

Mr. Sorby's New Micro-spectroscope.—This instrument, which was briefly noticed in its original form at page 148 of vol. i., has since been modified and improved, and was exhibited at the meeting of the Society, on 8th January.

The principal advantages of the instrument are the small size (half the ordinary size) combined with great dispersive power and excellent definition, with large field of view over the whole spectrum.

To obtain this, a change in the ordinary mode of construction has been adopted, the achromatic object-glass focussing the slit being placed, not below the prism as usual, but above it, close to the eye. A much longer focus can therefore be obtained for the object-glass, and consequently better definition. To collect the light coming from the slit, a cylindrical lens is fitted behind the prism and gives an even, bright light far into the extreme ends of the spectrum, so that no shifting of slit or micrometer arrangement is required. Without any trouble of re-adjustment the object-glass also focusses a micrometer scale which extends over the whole spectrum, and consequently

wave-lengths can be read off with ease in every part. The comparison prism is placed at right angles to the line of the slit, and enables both spectra to be focussed sharply at one and the same time.

Mr. Hilger, by whom it is made, calls it "the Miniature Microspectroscope."

The Structure of Blood-vessels.—Ranvier * has described peculiar spindle-shaped extensions in the blood-vessels of the red muscles of rabbits—a kind of small aneurism. They are found in the capillaries, especially where they merge into each other, and in small veins. These extensions, according to Ranvier, are the reservoirs for blood, from which the muscles at the moment of contraction draw oxygen.

These extensions of the blood-vessels are not only found in red muscle, but also in other contractile tissues. Professor P. Peremeschko says † that he has found them finely developed in the Lig. nuchæ of dogs and cats. They are situated chiefly in the capillaries, but also in small arteries and veins. Their number is much more considerable here than in muscle; they are often placed in one and the same vessel in rows alongside of each other, so that the injected vessel assumes the form of a string of pearls. Their shape is sometimes spindle-like, sometimes oval, sometimes quite round. In young animals their length and thickness and number are less than in full-grown animals. In embryos during the first half of gestation they are entirely wanting, and appear only at the end of that period in the form of scarcely recognizable thickening of the vessels.

Borings of a Sponge in Marble.—Some fragments of white Italian marble were recently presented to the Peabody Museum of Yale College, U.S. The marble was part of a cargo wrecked off Long Island in 1871, and taken up in 1878. The exposed portions of the slabs were thoroughly penetrated to the depth of one to two inches by the crooked and irregular borings or galleries of the sponge *Cliona sulphurea*, Verrill, so as to reduce it to a complete honeycomb, readily crumbling in the fingers. Beyond the borings the marble was perfectly sound and unaltered. The rapid destruction of the shells of oysters, &c., by the boring of this sponge has, Mr. Verrill says,‡ been long familiar to him, but of its effects upon marble or limestone he has not before seen examples; for calcareous rocks do not occur along the portion of the American coast which it inhabits. Its ability to rapidly destroy such rocks might have a practical bearing in case of submarine structures of limestone or other similar materials.

Alcoholic Fermentation.—M. Pasteur has carried out his intention of making a critical examination of the MSS. of the late Claude Bernard,§ which M. Berthelot stated contained a refutation of M. Pasteur's theories. The result of this examination is published in No. 22 of the last volume of the 'Comptes Rendus,' ‖ where it occupies

* 'Arch. de Physiol.,' 1874, t. 1.
† 'Zoologischer Anzeiger,' vol. i. p. 200.
‡ 'Am. Jour. of Sci. and Arts,' vol. xvi. p. 406.
§ See vol. i. p. 271.
‖ 'Comptes Rendus,' vol. lxxxvii. p. 813.

six pages. M. Pasteur describes the MSS. as "one of the most curious revelations possible of the influence of a defective system on a person extremely exact and given to rigorous experimentation. It is a sterile attempt to substitute for well-established facts the deductions of an ephemeral system. The glory of our illustrious confrère cannot be diminished by it. The errors of those who have accomplished a valiant career have only the philosophic interest which belongs to the recognition of our human weakness. Men are great only by the services which they have rendered, a maxim which I am happy to borrow from Bernard's last words."

Dry Preparations of Diatoms, &c.—Although there are many processes for making balsam preparations of very thin objects which are required to be placed in the most favourable position for observation, or in a particular order, yet few are able to accomplish this readily in the case of dry preparations except M. Möller, whose process is a secret.

The following is said by M. G. Marmod in the 'Journal de Micrographie' * to be a very simple method. Heat a small quantity of oil of cloves, and expose a slide to the vapour until there is deposited on the slide a series of very small drops. These drops take an hour or two to evaporate completely, and there is therefore plenty of time to arrange the diatoms or other objects, which will remain after the evaporation solidly fixed and without deposit.

The Organs of Attachment of Stentors.—From an examination of *Stentor cœruleus*, Professor A. Gruber has succeeded † in finding out how these animals effect an attachment to foreign objects. He agrees with Stein ‡ that a suctorial disk is never found, although sometimes a slight disk-shaped depression is seen at the posterior extremity of the body, but disagrees with Stein's further statement, that the attachment is effected by means of "very fine pseudopodia-like processes" of the sarcode, which radiate thickly from the posterior pole of the body and appear like a skein of elongated bristle-shaped cilia. No structure of that kind was found in *S. cœruleus*, though vibratile cilia were seen which were longer than the rest, and which doubtless gave rise to Stein's description.

In all Stentors there are to be found immediately after they have detached themselves, variously shaped small appendages at the posterior extremity of the body, which on closer examination prove to be amœboid processes of the sarcode. When the animal has no opportunity of attaching itself these processes disappear, for the most part somewhat rapidly, after repeatedly changing their form, and the end of the pedicle appears uniformly rounded. On the other hand, in the case of an animal which has found an object to which it can attach itself, it is seen that the processes, mostly finger-shaped or drawn out into fine pseudopodia, are clasped round the object.

If the view of Stein were correct, that the muscle-stripes of the

* 'Journal de Micrographie,' vol. ii. p. 506.
† 'Zoologischer Anzeiger,' vol. i. p. 390.
‡ 'Der Organismus der Infus.,' II. Abth. p. 224.

Stentor are continued to the posterior pole of the body, it would be difficult to conceive how these fluid amœboid processes could be formed from the cortical layer to which the muscles belong. Gruber saw, however, that the muscle-stripes do not converge to the pole, but that a small space, which forms the posterior extremity of the body (probably the disk-shaped cavity of Stein) remains free from them.

Here the structureless sarcode appears therefore in its natural state, as can be seen when the part is viewed from above. Though this in different states of contraction may change very much in size or even almost disappear, yet it always is there and can send out pseudopodia at any moment. In this way an explanation is found as to how those amœboid processes originate, which render it possible for the Stentor to attach and again detach itself at will.

A new Method of preparing a Dissected Model of an Insect's Brain from Microscopic Sections.—At the meeting of the Quekett Microscopical Club of the 24th January, Mr. E. T. Newton described a very ingenious method which he had devised. The brain modelled was that of the common cockroach (*Blatta orientalis*), and the method was as follows:—The brain properly hardened was cut up into a consecutive series of slices, each being mounted and numbered. An enlarged drawing of each section was then made with a camera lucida, and these drawings transferred to pieces of wood of a thickness proportionate to the thickness of the sections, and then cut out with a saw. By piling together in their relative positions this series of slices of wood and trimming off the angles, a model of the external form of the brain was produced which can be taken to pieces so as to show the drawings of the sections upon their faces. The series of slices which make up the right half of the brain were then taken and the more important structures in each cut out like a child's dissected map puzzle. The corresponding structures were taken from each slice and fixed together in their relative positions, in such a manner that the whole may be fitted together, and when desired the more important parts may be, as it were, dissected out. The President (Professor Huxley) highly commended the ingenuity of the method and the manner in which it had been given effect to in the model—an expression of approval which was fully endorsed by the meeting.

The Relations of Rhabdopleura.—This singular Polyzoal genus was the subject of a communication by Professor Allman, Pres. L. S., at the meeting of the Linnean Society of the 19th December. He maintains that the endocyst, hitherto supposed absent, is really represented by the contractile cord which seems to take the place of the funiculus in the fresh-water Polyzoa. In Rhabdopleura the endocyst has receded from the ectocyst, and its wall approximation and nearly complete obliteration of cavity has become changed into the contractile cord. Anteriorly it spreads over the alimentary canal of the polypide, to which it becomes closely adherent, and here represents the tentacular sheath. Posteriorly the endocyst undergoes greater modification, the contractile cord becomes chitinized, and converted into the firm rod which runs through the stem and branches over all the older parts of the colony, and which still presents in its narrow lumen a trace of

the original cavity of the endocyst. The very remarkable shield-like appendage which is attached to the lophophore G. O. Sars regards as epistome. Professor Allman traces its development as a primary bud from the modified endocyst, and it again budding the latter finally becomes the definitive polypide, while the primary bud remains as but a subordinate appendage. We have thus in Rhabdopleura an alteration of heteromorphic zooids.

Formation of Ovisacs in Copepoda.—In a recent work (on two fresh-water Calanidæ) Dr. Gruber, of Freiburg, in Baden, expressed the conjecture that in some Copepoda the secretion for the formation of the peculiar (so-called) ovisacs consisted in part of the emptied contents of the adherent spermatophore. He now finds * that this is not so, as he intends to show in a subsequent publication on the structure of the sexual organs and the reproduction of Copepoda. The secretion originates, as is seen in *Diaptomus*, in the oviduct itself, and is forced out by the eggs on their exit through the sexual opening, and, being hardened in the water, forms the sac. He has also demonstrated the existence of a secretion in *Cyclops* filling the oviduct up to the vulva, which certainly has the same object.

The Conidia of Polyporus sulfureus, and their Development.—M. de Seynes† has discovered in *Polyporus sulfureus*, Bull, the presence of secondary organs of reproduction.

A specimen of this fungus, gathered in the forest of Fontainebleau, presented in the superior part of the receptacle, which usually becomes white, a light drab tint and a very evident pulverulent state. Examined under the microscope, the coloured tissue disaggregated into a considerable number of small, rounded, free bodies, composed of an envelope, thick, smooth, and refractive, and with contents consisting almost wholly of an oily homogeneous nucleus, separated from the wall by a thin layer of hyaline liquid. They are spherical, with a tendency to become cruciform or oblong, and measure from ·005 mm. by ·006 mm. to ·016 mm. by ·019 mm. A certain number of them are borne by the elongated cells, whose structure is the same as those of the cells which form the pseudoparenchyma of the receptacle. These cells are cylindrical and have a thick refractive wall, sometimes quite obliterating their internal cavity. The ramifications branch off usually at right angles, and they present sudden inflexions; these characters are so clear that they cannot be confounded with any mycelium. We cannot then conclude that we have to do here with a parasitic vegetation originating from the exterior. The situation of these little bodies at the antipodes of the sporiferous tubes on the interior of the receptacle, gives rise to a legitimate comparison with the conidia of the receptacle of *Fistulina hepatica*. Thus we find extended to the genus Polyporus an anatomical and physiological arrangement which might seem to be confined to a genus of mixed characters, and exceptional in many respects.

The existence of endocarpous conidia in *P. sulfureus* reveals an unexpected affinity between the Polyporei and the Lycoperdoideæ.

* 'Zoologischer Anzeiger,' vol. i. p. 247.
† 'Comptes Rendus,' vol. lxxxvi. p. 805.

Here we have, in reality, a Polyporus of which the receptacle is angiocarpous, like that of th Gastèromycetes in the superior and conidian part, and which is gymnocarpous in the inferior and hymenial part. This receptacle becomes dry and brittle; the whole of the conidia in it have at maturity the appearance of a pulverulent gleba much more marked than in Fistulina. These elongated cellules scattered across this sort of gleba, produce the illusion of a capillitium.

The formation of the conidia is successive; it takes place at the extremity of the cellular ramifications; when a conidium has arrived at maturity and is detached, a second is formed below, and detached in its turn. This is the process of development which authors have called "acrosporous"; but here, as in the greater number of similar cases, there is only an illusory appearance. Even on a dry specimen it is easy to recognize the real genesis of the conidia by unequivocal signs, and by the aid of appropriate reagents. In the greater number the envelope is homogeneous and single; we find some, however, especially among the largest ones, which have empty spaces in the thickness of the wall itself; these spaces describe a curve, concentric with the double outline of the wall, and are situated at the two extremities of the longer diameter. They are sometimes united by a dark line which traces thus the separation of two distinct envelopes. We can see that the outlines of the external envelope are continuous with those of the parent cell. When the conidium is still adhering to it, the relatively great thickness of the different walls renders this observation easy and its interpretation very clear. A transversal septum is most often formed below the point at which the conidium developes itself, so as to form a chamber—a sporangium, it may be called—in which the conidium is organized. The wall of the latter adheres early to that of the parent cell, of which sometimes it does not reach the summit; at other times the adherence is interrupted, and even the space comprised between the inferior part of the conidium and the septum of the parent cell is filled with cellulose. The parent cell, impoverished and attenuated below the septum, breaks at this point, and the conidium carries with it the little cellulose appendage which served it as support. Sulphuric acid and the prolonged action of glycerine disassociate the conidium from the parent cell and make it appear free from all adherence in the cellular chamber in which it has had its origin; the preliminary phases of the germination produce the same result.

We have seen above that during the development of the conidium the wall of the parent cell becomes thinned for the benefit of the conidium; the same phenomenon is produced in the successive development of the cells of the receptacle; these facts led the author to examine the influence which is exercised on the properties of the fungoid cellulose by the displacements which it undergoes in the species which take up from the thick walls of their cells the materials for their nutrition and growth. The instability, the diminution of cohesion, doubtless imposed on the fungine by these displacements, seem to account for its property of turning blue on the contact of an iodine reagent, without becoming soluble in Schweitzer's liquid.

It might be said to pass through conditions more nearly allied to starch or to dextrine than to pure cellulose. Observations made on *P. sulfureus* and on several receptacles of Polypori, on *Ptychogaster albus*, &c., have shown the frequency of the blue or red reaction of iodine with fungine, contrary to what has been admitted hitherto. The cause of this apparent contradiction doubtless consists in the physiological phenomena here alluded to. It is worthy of remark that the organs on which was first observed, as a sort of anomaly, the blue reaction of iodine, belonged to the reproductive system, that is to say, to the cellular elements of most recent formation.

Polarizer for the Microscope.—At the meeting of the Physical Society on 9th November, Professor W. G. Adams, the president, explained a simple appliance made by Mr. S. C. Tisley for exhibiting the coloured bands due to interference with thick plates. The bands due to regular reflection and refraction were produced by two thick plates nearly parallel to each other and fixed in a brass box with rectangular apertures on its flat faces so that the light fell on the first plate at an angle of 60°, the whole apparatus being of a convenient size for the waistcoat pocket. The elliptical interference bands, due to the scattering or diffusion of light at a point on the front surface of one of the plates, were shown by means of a precisely analogous arrangement, except that the inclination of the plates to each other was somewhat greater; in this case the interference bands, formed by *regular* reflection and refraction, fall in another direction, so that they are not received by the eye; the diffusion interference fringes obtained were clearly visible when thrown on the screen. They are formed by rays once diffused from points on the first surface and afterwards regularly reflected and refracted from the front and back faces of the two plates in succession. Professor Adams pointed out that this instrument would form a convenient means of obtaining polarized light in cases where the length of a Nicol's prism is objectionable, for instance, under the stage of a Microscope; the light will be completely polarized if the plates be placed to receive the light at the polarizing angle, and the field will be much brighter than when a plate of tourmaline is employed.*

New Anthozoa.—Professor Studer, of Berne, continues in the July–August number of the 'Monatsbericht' of the Berlin Academy the description of the forms collected during the voyage of the 'Gazelle' round the world.

The new species (all of which are figured) are the following:—

Madrepora patella.	*Cereus brevicornis.*
" *selago.*	*Calliactis marmorata.*
" *candelabrum.*	*Bunodes Kerguelensis.*
" *rubra.*	*Bolocera Kerguelensis.*
" *nana.*	*Actinopsis rosea.*
Seriatopora Jeschkei.	*Paractis alba.*
" *compressa.*	*Halcampa purpurea.*
" *contorta.*	*Edwardsia Kerguelensis.*
Corynactis carnea.	

* 'Nature,' vol. xix. p. 68.

Forty-six other species (not new) are also mentioned, and most of them described, four being figured (*Madrepora tubulosa*, Ehrbg.; *M. formosa*, Dana; *Seriatopora oculata*, Ehrbg.; *Epizoanthus cancrisocius*, V. Mart.).

The last-mentioned form is parasitic on the outside of the shell of a whelk, the interior of which has again for a tenant a species of hermit crab. It is thus described:—Upon a flat basal membrane, which covers the shell of *Buccinum porcatum*, Gmel., inhabited by *Eupagurus*, rise the Polypes, which are 5–10 mm. high, and 4–7 mm. in diameter, at distances varying from 5–11 mm. They are principally on the dorsal side of the shell; the ventral side, which touches the ground by the motion of the *Pagurus*, having none. The whole of the basal membrane is penetrated with fine angular grains of sand, which consist for the greater part of quartz and a black hornblende. The spongy cœnenchyma completely absorbs the shell substance, and entirely takes its place. Even the spire consists of cœnenchyma impregnated with sand, excepting a small remainder, which is represented by a thin film of chalk. The tentacle disk of the naked polype is circular, the mouth small, and with two lips; on the circumference of the disk rise two circles of tentacles, the inner of which contains the largest tentacles. These are cylindrical, short, and not attaining the length of the circumference of the disk. Each circle contains twenty-four tentacles. The continuation of the body cavities of the polypes is formed by a fine network of canals which penetrate through the layer of cœnenchyma. From the bases of each polype further spread twenty-four canals as direct continuations of the chambers; after a short course, they lose themselves in a network of anastomosing canals, leaving only small spaces between, which are filled up with firm masses of cœnenchyma; they spread over the whole basal membrane. The colony when alive was rose red in colour. Six specimens of this beautiful form were taken in a drag net south of the Cape of Good Hope, in lat. 34° 13′ 6″ S., and long. 15° 0′ 7″ E., at 117 fathoms depth.*

Parthenogenesis in Bees.—According to a theory of M. Dzierzon developed by Professor Siebold, the eggs from which drone bees are produced, are deposited without fecundation by the queen, who can fecundate them or leave them unfertilized, according as they are intended to produce females or males. M. Pérez has recently discussed the subject in a note to the French Academy,† in which he says, "According to a classical theory, which had its birth in Germany and which no one now-a-days disputes, a fecundated egg of the queen bee is a female egg, and all unfecundated eggs of the queen bee are male. The mother bee, it is said, can even lay at will an egg of one or the other sex. This faculty, which is exceptional in the animal kingdom, is explained by assuming that the bee, at the moment of the passage of the egg into the oviduct, can apply to it or not a certain quantity of the seminal fluid contained in the seminal receptacle. Nevertheless, the organization of the generative apparatus of the bee

* 'Monatsbericht d. Köngl. Preuss. Akad.,' 1878, July–Aug., p. 524.

† 'Comptes Rendus,' vol. lxxxvii. p. 408.

does not differ essentially from that of the majority of female insects, to which no one has ever thought of ascribing the power of acting at pleasure upon phenomena which seem to be absolutely removed from the influence of the will." The theory was founded, at least in part, upon the supposed fact that an Italian queen, fertilized by a German drone, would produce hybrid workers and queens (females) and drones exactly like herself. M. Pérez, however, disputes this on the ground of observations made upon a hive, the queen of which, the daughter of an Italian of pure race, had been fertilized by a French drone.

Some of the workers were Italian, others French, others mixed in various proportions of the two races. Among the males also were some as dark as those of the French race, although, according to the above theory, they ought all to have been of the Italian race, like their mother. He therefore examined 300 of the drones, and found 151 were pure Italian, 60 were hybrids of various degrees, and 83 were French.

Hence he regards it as evident that the drone eggs, like those of the females, are fertilized by contact with the fluid stored up in the seminal receptacle of the queen, and that Dzierzon's theory must fall to the ground.

On this paper M. A. Sanson in a later number* comments as follows:—

In a recent note M. J. Pérez is inclined to throw doubt on the phenomenon of parthenogenesis amongst bees, taking his stand on a certain interpretation of facts of heredity which he has observed. I have reason to be surprised at seeing him qualify as an hypothesis a fact, experimentally proved a great many times, and of which the direct verification is most easy. A proof of this fact was submitted to the Academy in 1868.† I presented a comb containing only cells of workers filled with males or drones developed in these cells. M. Bastian and I obtained it at Wissembourg, by making a queen bee lay in it, whose seminal receptacle was destitute of spermatozoids. I presented also, at the same time, some workers lodged in male cells, and hatched from eggs laid by a fecundated queen bee who had no other cells at her disposal. The object of our experiments was to examine into the theory advanced at that time by Landois relating to the mode of development of the sexes. All bee-keepers know that the old queens, who become drone-mothers, that is, who no longer lay any but male eggs, have exhausted their provision of spermatozoids. When their seminal receptacle is examined under the Microscope, it contains nothing but a perfectly transparent liquid. It is also known that the temperature of a young fecundated queen has only to be lowered to the degree which kills spermatozoa, to render her immediately a drone-mother. The young queens who have not paired, and the workers who sometimes lay in hives which have lost their queen by accident, and which are called "orphans," only lay male eggs.

These are the facts. It is easy to show, moreover, that the inter-

* 'Comptes Rendus,' vol. lxxxvii. p. 659.
† Vol. lxxvii. p. 51.

pretation given by M. J. Pérez of his observations is not what it ought to be. In a hive of which the queen was, he says, the daughter of an Italian of pure race and had been fecundated by a French male, he examined with scrupulous care 300 males. He found Italian characters in 161; hybrid characters in varying degree in 66, and French characters in 83. From which it follows evidently, he adds, that the eggs of drones, like the eggs of females, receive the contact of the semen deposited by the male in the organs of the queen, and that the theory of Dzierzon, which was created to explain an ill-proved fact, becomes useless if this fact is disproved.

We are not at all struck by the evidence of such a conclusion, being in a position to interpose the known laws of heredity. With an Italian queen of incontestably pure race, the drones have exclusively Italian characters, although she may have paired with a male of another race. The workers alone are hybrids. The author has evidently had before him a case of reversion. In his hive there was, according to what he informs us, some true Italian workers, others which were French, others presenting a mixture, in different proportions, of the characters of the two races. This is conformable to the usual results of crossing. The queen of this hive was doubtless an Italian of the same kind as that of the workers of the first category. The atavism of a black male who had intervened in a preceding generation was manifested in different degrees. The same fact is often shown in the hives of Germany or of France in which Italian queens have been introduced. I remember having myself made a similar observation in that of M. Bastian, at Wissembourg, by proving the hybrid origin of the queen whose external characters were otherwise purely Italian.

In any case, the parthenogenesis of bees cannot be considered as an hypothesis admissible only by reason of its utility to explain a fact otherwise incontestable, since its reality was established by experiment long ago.

New Classification of the Vegetable Kingdom.—Professor Caruel, of Pisa, proposes the following classification:—(1) *Phanerogamia* (in the subdivisions discarding the distinction between Gymnospermia and Angiospermia, retaining as the two primary classes Monocotyledons and Dicotyledons, and giving the higher rank to the former). (2) *Schistogamia* (including *Characeæ* only). (3) *Prothallogamia* (vascular Cryptogams divided into *Heterosporæ* and *Isosporæ*). (4) *Bryogamia* (synonymous with *Muscineæ*, and divided into *Musci* and *Hepaticæ*). (5) *Gymnogamia* (Thallophyta or cellular Cryptogams). The simplest Gymnogamia possesses only a single form, which is reproduced organically by fission, by conidia and sporidia, or by gamogenesis, but without any sexual differentiation. In others there is sexual differentiation into male and female forms; a few have also a third neutral form, when the oospore produces zoospores instead of passing directly into the female form. They resemble the *Bryogamia* in the definite development of the neutral form and the indefinite development of the female form, but differ in the zoospore-like form of the phytozoa, and in the structure of the oogonium, which is iso-

lated, and naked, and does not form parts of an archegonium. Professor Caruel altogethor discards the old classification of Thallophytes into Algæ, Fungi, and Lichens, but does not propose any other in its place, and thinks it probable that as our knowledge of some of its forms increases, it will be broken up into several primary groups. He considers it would be an advantage if the term Cryptogamia were altogether discarded.*

The Morphology of the Oxytrichina.—Some important observations have been made by Professor V. Sterki on this subject,† which may be shortly summed up as follows:—

1. *Form and Size.*—The Oxytrichina and indeed the whole group of Hypotricha are usually described as having a convex dorsal and a flat ventral side. This is not universally true: *O. gibba* (*Amphisia gibba*, Sterki) has the ventral side concave with prominent edges, while other forms are equally convex on both surfaces; one is rounded and spindle-shaped, and another has a flat dorsal side. Distinct varieties of some species have been observed, as well as undoubted monstrosities.

2. *Body-substance—Consistency.*—Muscle-striæ (Myophanstreifen) occur in some cases. In *Stylonichia mytilus* suffering from want of water, all the protoplasm was seen to form a network enclosing communicating vacuoles in which was contained a watery fluid or "serum." Probably the contractile vesicle is a modified vacuole. There is an unbroken chain of transition forms between species with a carapace and those possessing the greatest amount of "Metabolicität" or power of changing their form.

3. *Peristome.*—The structure in the œsophagus of *Stylonichia*, described as the mouth-cleft by Stein, and as a second undulating membrane by Engelmann, is really a row of long, delicate, undulating cilia; the author calls these the *endoral* row. He also describes a row of *paroral* cilia, inserted along the line of attachment of the adoral row, and directed inwards.

4. *Ciliation.*—Those cilia which are disposed in rows are usually fewer in number and of greater size than they are usually represented. Thus Sterki counts forty to fifty large cilia in the adoral row of *Stylonichia mytilus*, as against the 200 fine ones of Stein. There is no absolute distinction in nature between styles and bristle-like cilia; moreover, in one and the same species intermediate forms are met with between the finest cilia and the strongest "styles." The marginal and anal cilia are of a flattened form; the large frontal and ventral cilia of *Stylonichia* and *Oxytricha* are often polygonal in section; in *S. mytilus* some of the frontal cilia are semicircular in section. The flattening of cilia is most marked in the adoral set, which are so modified as to form fan-like plates, called by the author membranelles (Membranellen); he finds them in all *Oxytrichæ* as well as in *Euplotæ* and *Amphidiscæ*, in the peritrichous *Halteria* and in *Stentor*. When in action, the opposite edges of the row of membranelles give the appearance of a double row of cilia. In the matter of the location of

* Mr. A. W. Bennett, in 'American Naturalist,' vol. xii. p. 747.
† 'Zeitsch. f. wiss. Zool.,' vol. xxx.

cilia there are two distinct groups of *Oxytrichina*, or rather two extreme modifications with intermediate forms. In one of these, including *Oxytricha*, *Stylonichia*, &c., the cilia are greatly differentiated both as to form and function, and limited in number: in the other (*Uroleptus*, *Urostyla*) there are two rows and upwards on ventral cilia, each row containing an indefinite number. A new genus and species, *Trichogaster pilosus*, is interesting from the fact that it is the lowest known form of *Oxytrichina*, its cilia presenting the smallest amount of differentiation.

For the sake of clearness, the author proposes to distinguish by numbers the eight characteristic frontal cilia of *Stylonichia*, *Oxytricha*, *Histrio* (nov. gen.), *Pleurotricha*, and *Allotricha* (nov. gen.). The dorsal cilia are not, as Stein thought, young marginal cilia. They occur over the whole dorsal surface in longitudinal rows, each row being set in a distinct furrow. They exhibit little movement, and are differently constructed to the other cilia, being mere cuticular processes, containing but little protoplasm. They may be absent.

5. *Transverse Division.*—A very exact account is given of the development of the new cilia of the two daughter-individuals arising by a process of transverse division. According to Stein, the new marginal cilia arise as a single longitudinal row on each side, which subsequently divides: but according to Sterki this account is incorrect. He states, in fact, that the mode of origin of the marginal cilia is different on the right and left sides, and takes place as follows:—On the right side the row of marginal cilia of the parent splits up into three groups, enclosing two intervals, in each of which appear fine close-set cilia. These arise somewhat nearer the margin than the old cilia, and, as development goes on, they get further and further from one another, the rows themselves, at the same time, approaching. The old cilia simultaneously undergo absorption, although young individuals are often met with which have some of the maternal cilia left. On the left side the parental marginal cilia split up into only two groups: in the single interval between them appears one of the new rows, the second making its appearance between the anterior end of the old row and the adoral cilia. A further difference between the two sides is met with in the fact that the new marginal cilia of the left side arise further from the margin than the old ones.

In *Stylonichia*, *Oxytricha*, and *Histrio*, the frontal, ventral, and anal cilia of each daughter-cell arise from a common group of eighteen cilia, that of the anterior individual being situated to the right of the parent peristome, that of the posterior individual to the right of the new peristome. Each group consists of six oblique rows, containing 1, 3, 3, 3, 4, 4, cilia respectively, counting from left to right. Of these the single cilium of the first (leftmost) row, the two anterior cilia of the second and third rows, and the three anterior of the sixth, become the eight frontal cilia; the two anterior cilia of the fourth, and the three anterior of the fifth row, become the five ventral cilia; while the posterior cilium of each row except the first becomes one of the five anal cilia.

During division, the anterior or old peristome alters its form,

becoming slender and flattened like the new or posterior peristome. Afterwards, both peristomes increase in length and breadth, so that at the end of the process they are both in the same stage. The new caudal cilia always arise, as Stein made out in *Stylonichia*, on the dorsal side: the præoral cilia and undulating membrane are formed anew, the old ones being absorbed. The adoral cilia or membranelles are probably directly transformed, like the peristome, into those of the new individual. The new cilia all exhibit a sort of clumsiness of movement, quite different to the facility of their adult motions.

The author remarks that the process of division in *Oxytrichina* is not one of true fission, but is rather one of bud-formation.

In an appendix Sterki gives the characters of some new genera and species he has established. The new genera are *Histrio* (= *Stylonichia histrio*), *Amphisia*, and *Gonostomum* (separated from *Oxytricha*), *Stylonethes*, *Allotricha*, *Strongylidium*, and *Trichogaster*.

The Sexual Process in Diatoms.—An article on this question, containing a discussion on the sexual process in general, occurs in 'Der Naturforscher' for November 23, 1878. The writer begins by a statement of the five methods in which the auxospores of Diatomaceæ are known to be formed: these are the following:—

1. A single individual throws off both valves, secretes a mucilaginous investment, extends itself, and grows. The auxospore thus formed surrounds itself with a thin membrane devoid of silica, and within this secretes the usual pair of siliceous valves, thus forming the "firstling-cell" (Erstlingzelle) of a new generation.

2. The protoplasm of a cell divides into two naked daughter-cells, which make their way out of the mother-cell, and form an auxospore.

3. Two individuals, lying close to one another, secrete an investment of mucilage: both these throw off their valves, and so form a pair of naked cells lying in close proximity to one another, but without actually touching. Both of these extend parallel to one another in the direction of their length until they attain the normal size of auxospores; outside these a thin membrane (perizonium) is found, and within this the ordinary siliceous valves.

4. Two individuals, generally surrounded by a gelatinous investment, throw off their old valves, and coalesce into a single naked mass of protoplasm, which grows into a single auxospore.

5. Two individuals, again surrounded by mucilage, throw off their old valves, and each divides transversely into two naked daughter-cells, each of which then coalesces with the corresponding daughter-cell of the other individual. Two naked zygospores are thus formed, each of which becomes an auxospore, and subsequently, by the formation of siliceous valves, a firstling-cell.

Of these five methods the fourth and fifth are certainly sexual, being a process of zygospore-formation. The first mode is as certainly asexual, a process of cell-formation by rejuvenescence, so that in the single group of *Diatomaceæ* the auxospores, by which a new generation is started, may be produced either sexually or asexually.

The second mode requires further investigation: about the third there is a difficulty; it is a process of rejuvenescence, taking place,

however, only when two individuals are present; so that a mutual action, independent of actual contact, is evidently exerted. This process the writer compares to the mode of fertilization in *Florideæ*, where cells far removed from the trichogyne, to which alone the fertilizing influence of the spermatia is applied, are stimulated to a new and vigorous growth by the impregnation; and to the process which obtains in Phanerogams, where the protoplasms of the male and female cells are separated from one another by the cell-wall of the pollen tube. In both these cases, however, one of the sexual cells only (the female cell) undergoes further growth, the other or male cell disappearing; while in the desmids in question, the action of the two cells is mutual.

The writer then defines sexuality as the action of two or more cells on one another, by means of which a new process of growth, in one or all of these cells, is set up, and the sexual action consists in the stimulation of the sexual cells to a new and peculiar growth, such growth being impossible without that stimulation.

Microscopical Injection of Molluscs.—Dr. W. Flemming has originated * a method of killing molluscs for purposes of fine injection, which he has found very successful. He recommends freezing the animal by means of a mixture of ice and salt, and placing it, when frozen, in tepid water for a quarter of an hour; it is then found to be dead and stiff with the valves gaping, and the muscles no longer offer any opposition to the passage of the injection. Unlike many other methods of killing, this freezing process produces no injury to the tissues.

In injecting Lamellibranchs from the heart, there is great danger of extravasation. To obviate this difficulty, Flemming recommends wiping the surface carefully after insertion of the cannula, and then covering the animal with a soft paste of plaster of Paris. If this is done successfully, the cannula is firmly fixed in its place, and extravasation from the cut surfaces of the adductors and other dangerous places is effectually prevented.

Parasitism amongst Infusoria.—Dr. J. van Rees † has observed three cases of parasitism in this group, two of which are new, while in the case of the third his account differs somewhat from that of its discoverer.

1. *Vorticella microstoma.*—The curious parasite *Endosphæra* having this species for its host, was first described by Engelmann in the first volume of the 'Morphologisches Jahrbuch.' *Endosphæra* is a peritrichous infusor found in the interior of the body of *Vorticella*, where it multiplies by budding, the buds making their way out of the body of their host and swimming freely in the water for a longer or shorter time, until another *Vorticella* is met with. Engelmann stated that the parasite is then taken into the body of its host by the ciliary current of the latter, but, according to Rees, it fixes itself about halfway between the proximal and distal ends of the *Vorticella's* body, into which it gradually penetrates, still showing its nucleus and con-

* 'Archiv f. Mik. Anat.,' vol. xv. p. 252.
† 'Zeitsch. f. wiss. Zool.,' vol. xxxi. p. 473.

tractile vesicle. Engelmann found that a posterior circlet of cilia was developed in the infected *Vorticella*, which then swam away, but in the cases observed by Rees, the *Vorticella* drew itself together and sometimes became encysted. In one case quite an *Endosphæra* epidemic was observed.

2. *Vorticella campanula.*—Amongst normal individuals some specimens were seen containing large, strongly refracting spheres, exhibiting a single contour, granular contents, and a dark, strongly refracting, spherical or oval nucleus; no contractile vesicle was observed. Each *Vorticella* contained from two to eight of the spheres, the size of which was inversely proportional to their number, but usually constant for each infected specimen. In one case, however, one sphere was decidedly larger than any of the other in the same specimen, and had two nuclei, whence it is inferred that multiplication takes place by division within the body of the host. The further fate both of host and parasite is unknown, and no opinion is advanced as to the nature of the latter.

3. *Oxytricha fallax.*—The appearance presented by the infected individuals in this case, seemed, at first sight, to lend great support to the theory that the nucleus is a germ-producing organ. The parasite, to which, as in the preceding case, the author gives no name, occurs within the nucleus of *Oxytricha*, in the form, at first, of minute spheres, which are, except in the case of the smallest of all, nucleated, but are devoid of a contractile vesicle. In further stages the spheres increased greatly in size, and exhibited a distinct cell-wall, and underwent multiplication by fission. In the latter process the cell-wall took no part, and the division masses did not at first round themselves off. The nucleus of the *Oxytricha* became, of course, greatly altered in shape, and in the final stages usually disappeared. The spheres either escaped through an aperture in the substance of their host, or were liberated by its disintegration. In either case, the daughter-cells of spheres which had undergone division, rounded themselves off, after being liberated, and exhibited slow movements, due, the author thinks, to very minute cilia, which he believes he was able to see in some instances. After a time the movements ceased, and the daughter-cells were gradually transformed into a granular mass, devoid of any trace of cell-contours. The author seems to think it probable that the cell-colonies thus formed divide into single cells, and that these latter, or the products of their division, finally penetrate into the body of *Oxytricha fallax*. He believes the parasite to be one of the lower *Algæ*.

Microscopy at the American Association for the Advancement of Science.—At the meeting of this Association, to be held in August, 1879, Professor E. W. Morley, of Hudson, Ohio, will be the Chairman of the sub-section of Microscopy.

Germination of the Spores of Volvox dioicus.—Although the 'Journal de Micrographie' says that 'All microscopists are acquainted with the work of Cohn on *Volvox globator*,' * we believe we are correct in saying that very little was known of it in this country until the

* 'Beiträge zür Biologie der Pflanzen,' vol. i. part 3, 1875.

publication of Mr. A. W. Bennett's valuable summary of Cohn's views last year.* M. F. Henneguy, of the College of France, two years ago communicated to the Academy of Sciences a note as to the reproduction of *Volvox dioicus* (Cohn), in which he pointed out the gradual appearance of sexuality in these organisms, the male sex appearing before the female in proportion as the species degenerates by sexual reproduction. He has now added further observations, of which the following are the more important results.†

The spores arising from the fecundation of the oospheres by the antherozoids fall to the bottom of the water and remain in a stationary state for a long time. Cohn thought that these spores must be dried before germinating, though he did not observe the germination. Cienkowski saw the contents of the spore divide, and he thought that each sphere of segmentation became ultimately a cœnobium.

M. Henneguy has ascertained that, contrary to Cohn's opinion, the spores of *Volvox* pass the winter in the water. Those observed were collected in the mud of a basin of the Jardin des Plantes, deep and constantly filled with water.

These spores, of an orange-yellow, possess two enveloping membranes—an exospore with double outline, and a very thin endospore. At the moment of germination, the exospore is torn open, and the swollen endospore is seen to project through the openings. At the same time the contents of the spore, separated from the endospore by a clear space, divide into two equal parts, which, by successive bipartitions, give birth to four, eight, sixteen, &c., small cells. The cells, at first orange-yellow, acquire a brown tint, becoming more and more greenish in proportion as the work of division advances. When the segmentation of the spore has terminated, the cells form a spherical layer analogous to the blastoderm of a holoblastic ovum. Each element then acquires two vibratile cilia. The endospore disappears and the young *Volvox*, thus constituted, moves freely in the water. The cells, at first very close together, separate one from another by the interposition of a gelatinous matter.

A fact interesting to note is the presence among the vegetative cells of the *Volvox* still contained in the endospore, of elements larger than the others, which will subsequently give origin to the daughter colonies by a mode of division analogous to that observed in the spore.

The spores of *Volvox* therefore germinate in water, and each of them produces a single colony by a process of segmentation identical with that which gives rise to a daughter colony at the expense of a cell of the mother colony.

Parasitism of a Coral on a Sponge.—The discussion at the January meeting on this subject will be found in the 'Proceedings' at p. 110.

* See 'Pop. Sc. Review,' N. S., vol. ii. p. 225.

† 'Journal de Micrographie,' vol. ii. p. 485. 'Bull. Soc. Philomath.,' Paris, July, 1878.

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Notes on some of the Reticularian Rhizopoda of the 'Challenger' Expedition. By Henry B. Brady, F.R.S. (3 plates.)

Researches on the Flagellate Infusoria and Allied Organisms. By O. Bütschli, Prof. of Zoology in the Univ. of Heidelberg. (1 plate.) (Abridged from 'Zeitsch. f. wiss. Zool.,' vol. xxx.)

On the Morphology and Systematic Position of the Spongida. By F. M. Balfour, M.A., Fell. Trin. Coll. Camb. (3 woodcuts.)

Flagellated Organisms in the Blood of Healthy Rats. By Timothy Richards Lewis, M.B. (1 woodcut.)

Notes and Memoranda.—Observations on the Capitellidæ by Dr. Hugo Eisig. By F. M. Balfour.—Bacteria as the cause of the Ropy Change of Beetroot Sugar. By Prof. Lankester.—Stein's 'Organismus der Infusionsthiere.'

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* The contents of Microscopical Journals are given in full; in other cases such of the contents as relate to Biological subjects (principally Invertebrata and Cryptogamia), or are otherwise interesting to Microscopists.

Annals and Magazine of Natural History, Fifth Series, Vol. III., No. 13 (January):—

Supplementary Observations on the Anatomy of *Spirula australis*, Lamarck. By Prof. R. Owen, C.B., F.R.S., &c. (3 plates.)

On *Plectronella papillosa*; a new genus and species of Echinonematous Sponge. By W. J. Sollas, M.A., F.G.S., &c. (4 plates.)

On the Bryozoa (Polyzoa) of the Bay of Naples. By Arthur Wm. Waters, F.L.S., F.G.S. (4 plates.)

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The Development of the Embryo of Horse-tails. By R. Sadebeck. (3 plates.)

Contributions to the Germination of the Schizæaceæ. By H. Bauke. (4 plates.)

JENAISCHE ZEITSCHRIFT FÜR NATURWISSENSCHAFT, N. S., Vol. V., Part 4:—

Action of Light and Heat on Swarm-spores. By Dr. E. Strasburger.
On Polyembryony. By Dr. E. Strasburger. (5 plates).

MORPHOLOGISCHES JAHRBUCH, Vol. IV. (Parts 1–3 and Supp.):—

Anatomy of *Isis Neapolitana*, nov. sp. By G. v. Koch. (1 plate.)
Observations on the Synonymy of *Isis elongata*, Esper, with *Isis Neapolitana*. By G. v. Koch.
Contributions to the Anatomy of *Chiton*. By Dr. H. v. Ihering. (1 plate.)
Observations on Neomenia and on the Amphineura in general. By Dr. H. v. Ihering.
Contributions to the knowledge of the Formation, Fecundation, and Division of the Animal Ovum. Part III. By Dr. O. Hertwig. (6 plates.)
Communications on *Gorgonia verrucosa*, Pall. By G. v. Koch. (1 plate.)
On the Degeneration of the Visual Organs in Arachnida. By Ant. Stecker. (1 plate.)
On *Gloidium quadrifidum*; a new Genus of Protista. By Prof. N. Sorokin. (1 plate.)
The Skeleton of the Alcyonaria. By G. v. Koch. (2 plates.)
Communications on the Cœlenterata. On the Phylogeny of the *Antipathidæ*. By G. v. Koch. (1 plate.)
On the Origin and Development of the Elastic Tissue. By Dr. L. Gerlach. (2 plates.)
Minor Communications, &c.—Are the Segmental Organs of the Annelida homologous to those of the Vertebrata? A Reply to Dr. Fürbringer. By C. Semper.—Muscle-epithelium in Anthozoa. By Dr. O. Kling. (Preliminary communication.)—Review of H. Grenacher's Researches on the Anthropod Eye.

ZEITSCHRIFT FÜR WISSENSCHAFTLICHE ZOOLOGIE, Vol. XXXII., Part 1 (issued 19th December, 1878):—

On the Sexual Organs of the Cephalopoda. First contribution. (4 plates.) By J. Brock.
Researches on the Structure and Development of Sponges. Sixth communication: The Genus *Spongelia*. (4 plates.) By F. E. Schulze.
Studies on the Anatomy of Respiratory Organs. 1. The Anatomy of the Gill of *Serpula*. By L. Löwe. (1 plate.)

MONATSBERICHT DER KÖNIGLICHEN PREUSSISCHEN AKADEMIE DER WISSENSCHAFTEN ZU BERLIN* (1878, February):—

On the Reflexion of Light by the Surfaces of small Crystals. By Herr Websky. (Concluded, with a plate, in the July–August number.)

March:—

The Nerve-system of the Chætognatha. By Prof. Langerhans.

April:—

On the Specific Heat of Animal Tissue. By Prof. Rosenthal.
Summary of Arachnida collected in Mozambique. By Dr. F. Karsch. (2 plates, containing microscopic details.)

May:—

Investigations of Absorptive-spectra (of Inorganic and Organic Bodies). By Herr H. W. Vogel. (2 plates.)

* These will be referred to hereafter as 'Monatsbericht—Berlin Academy.'

June:—

Congratulatory Address of the Academy to Professor Schwann on his Jubilee.

July–August:—

Second communication on the *Anthozoa polyactinia* collected during the voyage of the 'Gazelle' round the World. By Prof. Dr. Th. Studer. (5 plates.)

Austria.

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften.* Section I. Mathematics—Natural Science. Vol. LXXVII. Parts 1 and 2 (January and February):—

The Undulating Nutation of Internodes. A contribution to the Theory of the Longitudinal Growth of Plant-stems. By Julius Wiesner.

Note on the Relation of Phloroglucine and some allied Bodies to the Lignified Cell Membrane. By Julius Wiesner.

On the Degeneration of the Leaf-growth of some Amygdaleæ produced by Species of *Exoascus*. By Emerich Ráthay. (1 plate.)

Contributions to the fuller knowledge of the *Tunicata*. By Prof. C. Heller. (6 plates).

Parts 3 and 4 (March and April):—

On the Embryology of Ferns. By H. Leitgeb. (1 plate.)

On Peculiar Openings in the upper Epidermis of the Floral Leaves of *Franciscea macrantha*, Pohl. By M. Waldner. (1 plate.)

On the Origin of the Holes on the Leaf of *Philodendron pertusum*, Schott. By Frank Schwarz. (1 plate.)

Part 5 (May):—

The Nostoc Colonies in the Thallus of Anthocerotеæ. By H. Leitgeb. (1 plate.)

Researches on the Organisation of the Brain of Invertebrate Animals. Parts I. and II. (Cephalopoda, Tethys, Crustacea). By M. J. Dietl. (10 plates.)

Contributions to the Embryology of the Chætopoda. By Michael Stossich. (2 plates.)

Comparative Anatomy of the Seeds of *Vicia* and *Ervum*. By Dr. Günther Beck. (2 plates.)

Russia.

Bulletin de l'Academie Impériale des Sciences de St. Petersbourg,† Vol. XXIV., No. 4.

The Development of Cephalodia on the Thallus of the Lichen *Peltigera aphthosa*, Hoffm. By M. Babikoff. (1 plate.)

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* These will be hereafter referred to as 'Sitzungsberichte—Vienna Academy.'

† These will be referred to hereafter as 'Bulletin—St. Petersburg Academy.'

PROCEEDINGS OF THE SOCIETY.

Meeting of 11th December, 1878, at King's College, Strand, W.C.
Dr. C. T. Hudson, M.A., LL.D., Vice President, in the Chair.

The Minutes of the meeting of 13th November were read and confirmed, and were signed by the Chairman.

The following List of Donations received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Two dozen Slides of Insect Scales	*Mr. Davis.*
A Micrometer ruled with Divisions of an Inch and of a Millimetre	*Mr. J. Beck.*
A Cabinet for the Society's Instruments and Apparatus	*Mr. Frank Crisp.*

Dr. Hudson read a paper (Dr. Millar having taken the chair *pro tem.*) on a new species of *Œcistes*, sent to him by Mr. Oxley, which he had at first named *Œ. Sphagni*, but now proposed to call by the more descriptive name of *Œ. umbella*, from its peculiar shape, which was shown by coloured drawings (see p. 1). After some remarks as to the nature of *Conochilus volvox*, which, if it could be turned inside out, would have very much the appearance of a *Melicerta*, and commending the paper by Mr. Davis upon the subject, Dr. Hudson exhibited to the meeting some beautiful coloured transparent diagrams, prepared by himself, of Rotatoria, which he showed in the darkened room by means of three duplex lamps placed behind them. The series comprised *Œcistes crystallinus*, *Limnias ceratophylli*, *Limnias annulatus*, *Cephalosiphon Limnias*, *Melicerta ringens*, *Melicerta tyro* (for which the new name of *M. Tubicolaria* was proposed), *Stephanoceros Eichornii*, *Floscularia campanulata*, *Conochilus volvox*, *Lacinularia socialis*, *Euchlanis triquetra*, *Pterodina patina*, *Actinurus Neptunius*, *Notommata aurita*, *Pedalion mirum*, *Trochosphæra æquatorialis* (from the Philippine Islands), and *Nais digitata*. The exhibition was accompanied by brief remarks, in the course of which Dr. Hudson observed that he thought that Mr. Bedwell in his excellent paper on *Melicerta* had credited that creature with rather more intelligence than it deserved. Mr. Bedwell had stated that when a particle came down to the mouth, it descended upon a kind of elastic cushion, and he had credited this cushion with a discriminating power such that the moment an object touched it there was an instant decision and disposal of it, and it was taken in or passed to the right or left or rejected according to its nature and fitness for food or building purposes. For his own part, he doubted this explanation of the phenomena, for the reasons mentioned in his paper. A curious instance was also related of what seemed very like intelligent action on the part of a specimen of *Floscularia campanulata*, which, having seized and enveloped an infusorion too large and straight to enable it to withdraw within its

case, was observed to descend in a fully expanded condition, and thus to set free the inconvenient prey.

The thanks of the meeting having been voted by acclamation to Dr. Hudson for his very interesting communication and exhibition, he resumed the chair.

Mr. Badcock thought that the name proposed by Dr Hudson, *Œcistes umbella*, was a very appropriate one. He had found the animal on April 4th, 1876, at which time he showed it to Mr. Oxley and others. It was the speciality of the umbrella-like structure which first drew his attention to it.

Mr. T. C. White inquired if the forms which had been exhibited were from fresh or brackish water?

Dr. Hudson said that all those they had seen were from fresh water.

Mr. F. H. Ward read a paper, "Improvements in the Micro-spectroscope" (see vol. i. p. 326).

Mr. Thomas Palmer said that, as far as the mode of measurement was concerned, he thought he could claim priority in the use of a photographed scale, as about three years ago he read a paper on the subject, and exhibited the apparatus. He should be very glad to see the micro-spectroscope improved, as he thought that it was not at present receiving a proper amount of attention, and he wished Mr. Ward every success in his endeavours to that end. In honour of their late President, Mr. Sorby, some good work ought to be done with it. If that gentleman's paper on "Vegetable Chromatology" was more read and studied, there would, he was sure, be more workers with the instrument than at present.

Mr. Crisp said that, in justice to Mr. Ward, the meeting should be reminded of the exact words of the paper which referred to the scale, and which he read (see vol. i. p. 329, lines 4–6). Apart from the question of the slit, Mr. Ward was entitled, he thought, to credit for the use he had made of the comparison prism. The Fellows would remember that he exhibited it at the May scientific evening, when great interest was taken in it.

Mr. Ward said he had tried to find out who was the originator of the scale, but had not been successful in doing so, though he knew it was not new, and had been in use for a long time in Germany: he was not aware that Mr. Palmer claimed it.

Mr. Crisp explained the points of his paper, "On some Recent Forms of Camera Lucida," a drawing of that of Dr. Hofmann being enlarged upon the black-board by Mr. Stewart (see p. 21). Mr. Crisp observed that there had been this year a glut of these instruments, as there were now four before the Society, viz. Hofmann's, Pellerin's, Swift's, and Russell's.

Dr. Millar said that the form last mentioned was one devised by Dr. Russell, of Lancaster, a brief description of which he then gave, illustrated by a drawing on the board.

Mr. Beck said that Mr. Crisp was quite right in saying there was

a glut of these instruments. As to this new one of Hofmann's, he could not see what the special advantage of it was. In the first place they had to take out the eye-piece because the reflecting surface was so far from it that they could not get any vision with it in its place. This he thought was a great disadvantage. Then, again, how was it proposed to see the pencil point? The rays were thrown on a piece of glass (A), (see Fig. 2, p. 21), and reflected to (B), and from that were reflected through the aperture (E). The observer at (E) looked through a piece of plate glass with two surfaces, and somewhere on the ground—upon the scale on which the drawing was made—he would see the object. If they did not mind the loss of light, they could get all the advantages claimed, by simply making a hollow Wollaston's camera; but in both cases they had the disadvantages of looking through two surfaces of glass, and a great loss of light. With all the changes which had been made at different times, he still believed that if persons would be careful to split the ray by looking with half the pupil only, and would also take the trouble to properly modify the light, there was nothing better than the old form.

Dr. Hudson said that as one who very frequently drew objects from the Microscope, he could only say that for such drawings as his of living objects the camera lucida was nearly useless. The method he adopted was to have a piece of glass ruled in squares, which covered the field of view; and, having ruled paper always at hand, the object was drawn square by square: and even the most active rotifer would sometimes remain quiet long enough to get the outline correctly. With an inanimate object he could not conceive anything more easy than this method, even to an indifferent draughtsman.

Mr. Ingpen said that Hofmann's camera appeared to be identical with one by Amici, which was forty years old at least. If the piece of glass (B) were extended, it would be the same exactly.

Mr. Crisp said it was only within the last few months that Dr. Hofmann had removed part of the plate of glass (B), the restitution of which would make the camera the same as Amici's, according to Mr. Ingpen's statement. In the drawing of this non-microscopic form, which appeared lately in 'Nature,' it was shown according to its original design.

Mr. Stewart read a Note by Mr. A. D. Michael with reference to the finding of the male of *Cheyletus venustissimus* (see vol. i. p. 317).

Mr. Crisp called attention to the remarks of Professor Adams at the meeting of the Physical Society, on 9th November, on the advantages possessed by a portable form of Dietzl's diffraction apparatus when used as a polarizer for the Microscope (see p. 87).

Mr. Ingpen made some remarks upon the $\frac{1}{8}$-inch objective exhibited by Mr. Crisp at the October meeting,* made by the Bausch and Lomb

* 'Journal,' vol. i. p. 312.

Optical Company, in which the cover correction was obtained by varying the thickness of a film of glycerine placed between the front lens and an external flat disk of glass, as described on p. 251 of the same volume. It was similar in construction to one made by Mr. Gundlach, and exhibited at a scientific evening in 1876, but showed considerable improvement. The figure and colour were excellently corrected, but the definition could hardly be considered brilliant. The cover correction was remarkably quick and satisfactory, a small alteration making all the difference between the best definition and none at all. The apparent angle of aperture was very large, but he thought part of it was "spurious," probably owing to reflection from the edge of the glycerine film. The working distance was inconveniently small, and as the adjustment was made inside the objective, it was close for very thin as well as for thicker covers. The method of correction was a very interesting one, and one which he thought might hereafter form a new point of departure in the construction of objectives.

Mr. Beck said that the Fellows would remember that recently a question was raised by the American Microscopical Congress as to whether the aliquot parts of an inch or of a metre should be used as a universal standard of microscopical measurement, and he then ventured to suggest that they should give the matter their attention. He had considered it, and he certainly should recommend that the divisions of the metre should be adopted. It was asked at the time whether the scales of the divisions of the millimetre could be obtained in the event of their being required; and having turned his attention to the matter, he had arranged a micrometer in which both scales could be seen. Having ruled a fiducial line, they had ruled on one side of it $\frac{1}{100}$ and $\frac{1}{1000}$ of an inch, and on the other side the $\frac{1}{100}$ of a millimetre, so that having the two scales on one slide there would be no longer any necessity for changing the slides every time they wanted to make a comparison. There would be a further advantage in having the two scales in this way for comparisons, because if there should happen to be any error or imperfection in the instrument used for ruling, it would be common to both scales. He had much pleasure in presenting one of these scales to the Society, and if any Fellow found anything which could be improved he should be happy to adopt the suggestion.

A Discussion took place between Mr. J. Mayall, jun., and Dr. Edmunds, as to the immersion prism referred to by the latter at the October meeting (vol. i. p. 309), and which Mr. Mayall claimed to have been originated and suggested by him, a claim which Dr. Edmunds on the other hand disputed.

The following were exhibited:—

Dr. Hudson:—Seventeen coloured transparent drawings of rotifers.

Mr. F. H. Ward:—(1) The micro-spectroscope and apparatus

referred to in his paper, and (2) two sections of broom, double stained by himself, which were much admired.

Dr. Millar:—The camera lucida devised by Dr. Russell.

Mr. Crisp:—(1) Hofmann's camera lucida. (2) Swift's ditto. (3) Dietzl's diffraction apparatus. (4) Stein's Infusoria, Part III. (the Flagellata). (5) Micro-photographs of botanical subjects, by De Bary.

Mr. J. Mayall, jun.:—(1) His two modifications of Dr. Woodward's "new device," in which the four exposed surfaces of the prism are utilized by cutting them at various angles, so as to approximate the angle of the illuminating rays to the semi-aperture of the objective likely to be used. One is an ordinary prism so cut, but with circular top for convenience of rotation, and mounted at the end of a brass tube with wide slots for the free intromission of light perpendicularly to each face. The other is a nearly hemispherical lens with the four faces cut on the spherical surface, and mounted on a rod attached to the centre of this surface. (2) A nearly hemispherical lens and a small semi-cylinder mounted conveniently for immersion illumination.

New Fellows:—The following gentlemen were elected Fellows of the Society:—Edwin W. Alabone, M.D., M.R.C.S., and John Simpson Harrison, Esq.

MEETING OF 8TH JANUARY, 1879, AT KING'S COLLEGE, STRAND, W.C.
J. W. STEPHENSON, ESQ., F.R.A.S. (TREASURER), IN THE CHAIR.

The Minutes of the meeting of 11th December were read and confirmed, and were signed by the Chairman.

The following List of the Donations received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Abbe, Dr. E.—Die Optischen Hülfsmittel der Mikroskopie. (Extracted from 'Bericht über die wissenschaftliche Apparate auf der Londoner Internationalen Ausstellung im Jahre, 1876')	*The Author.*
Badham, Dr. C. D.—The Esculent Funguses of England. 2nd ed. 1863	*Mr. Frank Crisp.*
Cooke, Dr. M. C.—Grevillea. Vols. I.–VI. 1872–8	*Ditto.*
Deby, Julien.—De la recherche Microscopique du Sang au point de vue Médico-legal. 1876. (Extracted from the 'Annales de la Société Belge de Microscopie')	*The Author.*
" " Ce que c'est qu'une Diatomée. 1877. (Extracted from the 'Bulletin de la Société Belge de Microscopie' for 1877), and five other papers	*Ditto.*

The Chairman having requested the Fellows to appoint two auditors of the accounts for the past year, Mr. Goodinge (proposed

by Mr. Curties, and seconded by Dr. Matthews), and Mr. Curties (proposed by Mr. Guimaraens, and seconded by Mr. Michael), were duly elected.

Mr. Stewart gave a *résumé* of a paper by Mr. W. J. Sollas, M.A., F.G.S., "Observations on *Dactylocalyx pumiceus* (Stuchbury), with description of a new variety, *D. Stuchburyi*," the chief points of interest in which were illustrated by diagrams drawn upon the black-board. The photographs and drawings which accompanied the paper were also handed round for inspection. (This paper will appear in the April number.)

Dr. Matthews said that he had been giving a good deal of attention lately to the subject of corals, madrepores and allied forms, and on examining them he thought he had found some evidences of parasitism. At the base of each of many specimens, he had found that there was a rough mass of stony material which he at first cast aside. Some time afterwards he was led to examine these parts in the hope of finding diatoms or foraminifera upon or in them, and he then discovered the curious fact that each coral was more or less based upon a sponge, and that it appeared to be a real case of parasitism. He at first thought that he had made a discovery, but further inquiry showed that there had been a paper written upon the subject by Mr. Carter.* He (Dr. Matthews) found that this state of things was shown in nine cases out of ten of the specimens examined by him. There were, however, some other specimens which displayed clear evidence of having been bored by a sponge. He had also found that certain sponges had become associated with some of the madrepores in such a manner, as to suggest the idea of a kind of mutual parasitism or commensalism, and also that in some cases the whole sponge had become enclosed and the cavity filled by sarcode and gemmules, the whole being fused together in such a way that it was hardly possible to tell by the Microscope where the gemmules ended and the corallum began; in fact, the fusion of the two seemed very complete and extraordinary, the thin layer of corallum extending completely over the sponge. He *had* found also some foraminifera, but had not yet had time to examine them. Mr. Carter in his paper did not mention any coral larger in size than ¼ inch, and this was described as being wholly on the surface of the sponge. He thought the matter was worth mentioning, and although it might be only one fact added to the great heap, it might some day be of use when dealt with by other hands.

Mr. Stewart said that very commonly before these corals arose as a branching stem they spread out in a thin layer, from which the corallum afterwards arose. They were very often fixed to a loose kind of oolitic rock, which was very friable and easily broken down, and it was easy to imagine how this kind of cap might involve a sponge. If what had been described occurred in this manner, he should hardly be disposed to call it a case of parasitism. In some kinds, however, such as the *Hyalonema* or glass rope sponge, they

* See vol. i. p. 288.

frequently met with a kind of true parasitism. It was also quite a common thing to find *Hydrozoa* and other things attached to the sponges.

Dr. Matthews said that he spoke with diffidence on the question of parasitism. He had a number of specimens to show after the meeting, and which he thought would help to elucidate the question.

On the motion of the chairman, a vote of thanks was passed to Mr. Sollas for his paper, the chairman saying he thought it had not been of any less interest from having been the means of eliciting the very interesting communication of Dr. Matthews.

Dr. J. Edmunds read a "Note on a Revolver Immersion Prism for Sub-stage Illumination," the subject being illustrated by diagrams, and by the exhibition of the apparatus described (see p. 32). A discussion ensued between Mr. Lettsom, Mr. Mayall, and Dr. Edmunds.

Mr. John Mayall, jun., read a paper "On Immersion Illuminators," various kinds of which he exhibited in illustration of the paper (see p. 27).

The Chairman inquired if Mr. Mayall had tried mounting objects otherwise than in balsam, because it appeared to him that water might be a very good medium.

Mr. Mayall said he had been working mainly upon objects in Canada balsam, but he had some time ago the opportunity of examining some of Professor Tyndall's bacteria, which were in water, and he then saw very clearly with the immersion what Mr. Dallinger had the greatest difficulty in making out.

The Chairman thought that the greater difference between the refractive index of diatom silica and water, as compared with balsam, would probably render the structure more visible if water was used.

Mr. Mayall said he remembered to have observed that such was the case.

The Chairman said that they had another paper by Mr. Mayall, "The Aperture question," and one by himself, "On a Catoptric Immersion Illuminator" (see p. 36), which must be taken as read, owing to the press of business before the meeting.

Mr. Crisp explained the views of Mr. Julien Deby in the paper he had sent entitled "Is not the rotiferous genus *Pedalion* of Hudson synonymous with *Hexarthra* of Ludwig Schmarda?" Dr. Hudson's drawings of *Pedalion* and that of Schmarda being laid before the meeting.

Mr. Stewart read part of a paper by Mr. Kitton, on "The Thallus of Diatoms," accompanied by comments on the views expressed by Dr. Lanzi and Mr. Kitton (see p. 38).

Mr. Crisp gave an account of the observations of Professor Graber, of Czernowitz, on some new sense-organs (supposed to be auditory)

in insects, and suggested that they would form a highly interesting subject for the further examination of microscopists, the more particularly as Professor Graber stated that for want of time he had been unable to complete the observations that required to be made in order to establish their exact character. The organs described were drawn on the black-board by Mr. Stewart (see p. 45, and Plate IV. Figs. 1, 1 *a*, 1 *b*, 2, and 2 *a*).

Dr. Matthews inquired if the hairs were supposed to perform the function of otoliths.

Mr. Stewart regarded the mode of nerve-termination of these organs as presenting the closest resemblance to that of the human auditory apparatus. He thought there seemed in all cases a special provision to prevent the otolith from touching the hairs. If they examined it in the bony fish they would find that there was an otolith convex on the side facing the brain, and this would come in contact with the hairs, but for the fact that they also constantly found deep grooves, which seemed as if they were to ensure that the otolith should be in as close a connection as possible without resting upon them.

The Chairman proposed a vote of thanks to Mr. Crisp for his very interesting description of the important observations referred to, and to the authors of the other papers which had been read that evening, which was carried unanimously.

The List of Fellows nominated for election as members of the Council at the ensuing annual meeting, was read in accordance with the 44th bye-law.

The following objects were exhibited:—

Mr. Ingpen:—(1) An old camera lucida, of the form designed by Amici, in which the image of the object is twice reflected, first by an opaque, and then by the first surface of a transparent mirror; the method being identical with that of Dr. Hofman described at the last meeting. (2) Also another, by Amici, in which the image of the object was reversed by a right-angled prism.

Dr. Matthews:—Specimens exhibiting parasitism of a coral on a sponge.

Mr. F. H. Ward:—Sections of mistletoe from an apple-tree—double stained.

Mr. Crisp:—(1) The Sorby miniature micro-spectroscope (see p. 81). (2) Recklinghausen and Meyer's pathological micro-photographs. (3) Specimens of microscopic printing issued by the Security Printing Company. (4) Muhr's "Wall Charts" of the anatomy of the head of insects.

Mr. Heneage Gibbes was elected a Fellow of the Society, and five gentlemen were proposed for election at the next meeting.

Walter W. Reeves,
Assist.-Secretary.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL, 1879.

TRANSACTIONS OF THE SOCIETY.

IX.—*The President's Address.* By H. J. Slack, F.G.S.

(*Read* 12*th February*, 1879.)

I am, unfortunately, quite unable to follow in the footsteps of Mr. Sorby, who, upon two occasions, brought before you in his Annual Addresses important original work, highly gratifying to those who value and desire to increase the scientific standing of this Society. Failing in this, it seemed most desirable to select a few points of interest for your consideration, arising out of recent invention and observation.

First, I would mention the introduction of the oil lenses suggested by Mr. Stephenson, and constructed under the direction of Professor Abbe by Herr Zeiss, of Jena. The objects of this invention are twofold; first, to do away with the troublesome necessity for making corrections with the screw collar introduced by Andrew Ross, and secondly, to obtain the largest angle of aperture with a good working distance. By selecting an oil, or mixture of oils having the same refractive power as the covering glass, it was expected that a fixed correction would suffice for any thickness. When the cover was thicker, as the working distance of the objective remained unchanged, there would be a thinner stratum of oil used upon the immersion principle, and when the cover was thinner the oil stratum would be thicker. After many trials, Professor Abbe found oil of cedar wood had very nearly the requisite properties when the illumination was with oblique light, and was improved for direct light by an admixture with oil of fennel seed. The glass made for Mr. Stephenson fully answered expectation. It had according to his description a balsam angle of 113°, its power was rather more than one-ninth, and the only correction it needed was a change in the length of the Microscope tube from 10 inches to 12 when very thin covers were employed. One result of using objectives of this construction, taken in connection with Professor Abbe's account of the way in which

lined objects can be viewed, or lined appearances produced, has been to throw fresh doubt as to the correspondence between actual structure, and optical effects of this description; and we are thrown back, as I pointed out in reference to insect scales long ago, upon the necessity of making various experiments, and of reasoning from the best analogies we can obtain in the interpretation of the appearances we see. Amongst those who have experimented with the oil lenses I may mention Dr. Pigott, who speaks of a No. 15 as a "magnificent glass."

It was not found by Mr. Dallinger, whose researches require the highest and most efficient optical aid, that the oil objectives showed anything he could not see with the Powell and Lealand glasses he usually employed, but he at once admitted and praised the great facility with which they could be used. He has since obtained excellent effects by using oil of cedar wood with Powell and Lealand's newest $\frac{1}{8}$, $\frac{1}{12}$, and $\frac{1}{16}$, and expresses great admiration for a new wet and dry $\frac{1}{50}$ by the same makers.

By the kindness of Mr. Baker, I had an opportunity of trying an $\frac{1}{8}$ and $\frac{1}{12}$. The latter I found a splendid glass, remarkable for the ease with which it displayed difficult objects, and requiring only a film of oil to connect it with the slide cover. The $\frac{1}{8}$ had such a large working distance that it required a little puddle of the oil, and on this account could only be employed with the Microscope in a vertical position. I am told that these glasses are not all alike in this respect.

The 'American Quarterly Microscopical Journal' for January, 1879, contains a letter from Professor Abbe, explaining that owing to a mistake several $\frac{1}{8}$ths have been made with a balsam angle of 107° to 109° only, instead of 114 to 116, as they should have been. He also states these objectives are composed of "four separate lenses," and not three, as Professor H. L. Smith supposed.

It seems probable, from Mr. Dallinger's experiments, and a few made by myself, that opticians may be able to furnish us with objectives that can be corrected for either oil or water; but if this cannot be satisfactorily accomplished, it is not likely that the oil lenses will supersede the water ones, though they have obviously some decided advantages for special purposes.

The fine performances of the large-angled glasses of the best makers, and the results obtained with the extreme angles of the oil lenses, have led in some quarters to a belief that great angles are good for all purposes; but there can be little doubt that this will be found a mistake, and that glasses of small and moderate angles, with fine corrections, will still be needed for much, and probably for most, valuable work.*

* See Dr. Pigott's paper "On the Invisibility of Minute Refracting Bodies caused by Excess of Aperture," 'M. M. J.,' February, 1875, p. 55.

Mr. Dallinger has pointed out that fine dry lenses are still necessary for many cases in which the use of fluids is objectionable, and this brings us to the consideration of the direction in which we must look for further progress.

It is now several years since Dr. Pigott called attention to the practical importance of the residual errors of the best objectives then made, and he proved experimentally that with the existing materials it was possible to reduce them. Since then important advances have been made, both with dry and wet lenses, and it is probable that for a further advance, to any important extent, the optician must be supplied with fresh materials.

Professor Abbe says, "The impossibility of removing each chromatic difference of spherical aberration has its root in the circumstance that, in the kinds of crown and flint glass at present provided, the dispersion always goes hand in hand with the mean index of refraction, in such a way that the higher dispersion is attached to the highest index. The outstanding aberrations might be completely, or very nearly, compensated, if an optical material were provided in which a relatively lower refractive index were united with a higher dispersion, or a higher refractive index with a relatively smaller dispersion. It would then be possible by combining such materials with the ordinary crown and flint glass to remove the chromatic and spherical aberrations which are partly disconnected, and thus fulfil the essential conditions arising from the chromatic difference." *

Professor Abbe also remarks upon the very small number of persons engaged in the manufacture of glass for optical purposes, and upon the few substances that have hitherto been employed in its preparation. Looking to the present conditions of manufacturing industry, which offer the largest gains to those who can produce at the lowest price articles required in great quantities, it is not probable that purely commercial considerations will induce anyone to devote attention to the demands of science for new kinds of glass or substitutes for glass, and the task is not likely to be undertaken unless through the help of private munificence, or State aid.

Besides glasses, which are chiefly silicates of potash, soda, and lead, with a little alumina or lime, &c., there seems a probability that a class of compounds resembling precious stones may come into optical use. M. Feil, a celebrated manufacturer of optical glass, and M. Fremy have succeeded in artificially producing rubies and sapphires, alumina minerals of high refractive power, and it is not impossible some quite new compounds may be formed. When Sir David Brewster experimented with jewel lenses, he spoke very highly of garnet, which is a compound of three or four silicates, chiefly of

* 'Die Optischen Hülfsmittel der Mikroskopie,' von Dr. E. Abbe, Professor an der Universitat zu Jena. Braunschweig, 1878.

alumina and lime. If the optician were supplied with fresh substances possessing the requisite properties, we might not only have objectives of more perfect corrections, but higher powers with flatter curves and larger lenses.

Passing from objectives to their employment and performance, we find Professor Abbe dealing with the conditions necessary for the resolution of close-lined and analogous objects, Mr. Dallinger measuring the flagella of *Bacterium termo* and finding them less than the 200,000th of an inch, and Dr. Pigott exhibiting, by remagnification, the image of a spider line diminished to the one-millionth of an inch.

If we consider the application of high powers to natural history, it is an interesting question how far the existing optical means enable the structure and rank of many of the minuter organisms to be discovered, and how far down in the scale sexual generation can be affirmed, or, with probability, assumed.

Professor Haeckel places amongst his Protista, eight classes of creatures, including Amœba, Flagellata, Diatoms, &c., and affirms of the whole list "that the most important physiological characteristic of the kingdom Protista lies in the exclusively non-sexual propagation of all the organisms belonging to it." * With regard to this statement, it may be mentioned that in 1863 Dr. Wallich published a remarkable series of observations on the form of Amœba he discovered in a Hampstead pond, and named *villosa* from its having a permanent villous organ protruding from one part. He stated that "one of the most remarkable amongst the most novel and varied characters of the Amœbæ consists in the vesicle, in which the true nucleus is contained, having been found to be distinctly membranous in some individuals." He noticed also "a clear nucleolus," and inquired whether the appearances presented justified the belief that the creature possessed "a germ cell and sperm cells." †

In April, 1875,‡ Messrs. Dallinger and Drysdale described a series of facts in the life-history of certain flagellate monads, including a sexual union, a division of nucleus, and formation of germs at first so minute as to be separately invisible, and then developing by several changes into the parental form. A magnification of 2600 diameters sufficed for watching these processes, and made the nuclei appear about one-eighth of an inch in their shortest diameter. One of the creatures in its most globular condition had, with that power, an apparent longest diameter exceeding one inch, and the shorter diameter a little under an inch. If we compare these dimensions with those of *Bacterium termo* magnified 4000 diameters, in Mr.

* 'History of Creation,' vol. ii. p. 69.
† 'Ann. N. H.,' May, 1863.
‡ 'M. M. J.,' May, 1875.

Dallinger's drawing represented in the September number of the new Journal,* we find the latter creature's body composed of two oval beads, each one seeming only about the size of the nucleus of the just mentioned flagellate monad, though the magnification is 1400 diameters greater. How much smaller living creatures may exist it is not possible to say, but with those of these dimensions we can scarcely expect any mode of vision furnished by the Microscope to enable the processes of their germ formation to be traced. Another difficulty of dealing with these organisms arises from the fact that it is only by unintermittent watching for a long time and under a variety of conditions that the whole cycle of their life changes can be made known. Mr. Dallinger has shown in the case of monads that the same species in different stages of development present very different aspects and behave in very different ways. The minute bacteria found to be capable of producing in animals the splenic disease which the French call *sang de rate*, has been found by other observers able under certain conditions to branch like the mycelium of a mould; and in M. Pasteur's book 'La Bière' will be found many illustrations of dissimilar growths of ferments, and fungi under different circumstances. After recounting many interesting experiments, M. Pasteur remarks that in the dust of a laboratory in which fermentations are studied, there are many germs which give rise to organisms which it is impossible to distinguish from alcoholic ferments, although they do not possess the properties of those bodies.

In endeavouring to avoid the error of lumping together a number of small organisms under a common heading, implying a very low stage of development, attention should be paid to any indications that may be obtained from their external organs, although their internal structure may defy scrutiny. An organism furnished with cilia in constant vibration is in that respect, and may be in others, below another in which ciliary motion, to use the words of the 'Micrographic Dictionary,' "is interrupted at intervals, apparently under the influence of a will." Of course, the term "will" is only employed to express a remote analogy. The difference appears to be that the ceaseless motion in one case responds to some continuous necessity, possibly that of respiration, while the intermittent one responds to a less frequent need, such as going in search of food. The "springing monad" of Messrs. Dallinger and Drysdale,† so called from its peculiar habit of coiling and uncoiling one of its flagella with a darting motion, not unlike the vorticella, carrying the body with it, evidently possesses an instrument superior to the simple cilium, and the same may be said of the "hooked monad" of these observers, a creature "with a persistent hook-like flagellum." The "calycine monad," to

* 'Journal R. M. S.,' vol. i. No. 4. † 'M. M. J.,' vol. x. p. 245.

which reference has already been made, is in its normal state like a cup, terminating in a slender pointed stem. It has nuclear bodies and two large "eye spots," with the strange "rhythmical opening and shutting" seen by these observers in some other monads. It is provided with four long flagella, and the authors say, its mode of locomotion is "a graceful gliding through the water, the flagella moving so often and so rapidly as to render their detection impossible when the monad is at its swiftest. They could roll over on their long axis, and change the direction of their motion with lightning-like rapidity, and, however crowded the field, not the slightest approximation to collision occurred." In this case the creature is big enough for some important internal organs to be seen, but had it been too small for this, or had none been open to detection, would not its remarkable and varied powers of locomotion have afforded fair ground for suspecting that it ought not to be ranked among the simplest unicellular bodies?

Before passing to another topic, a protest may be admitted against a not uncommon practice of describing some of the lowest living things as composed of a little mass of "homogeneous protoplasm." Is it not true, whenever magnification reasonably proportioned to the size of any organism can be applied, its protoplasm, so far from being "homogeneous," exhibits granulation, or particles differing in refractive power, and presumably in chemical properties from the mass?

The progress of discovery certainly leads to the belief that the processes and functions of the higher animals are developments of what is found low down in the scale. In a lecture "On the Phenomena of Life common to Animals and Plants,"* Claude Bernard said, "the principle of vital unity dominates in the entire history of animals and plants," and he characterized "nutrition" as "continuous generation." In another passage he said, "At the origin of every nutritive or generative phenomenon there is an organized agent, egg, germ, cell," and up to the present time the Spontaneous Generation Controversy has resulted in showing that there are no known means of obtaining any manifestations of new life, excepting as the products and results of previous life, acting, and acted upon, by appropriate surroundings. There is, however, another controversy still going on, in which the Microscope is indispensable, which has very wide and important bearings upon a variety of scientific questions, and which has a better chance of being finally settled.

This controversy relates to M. Pasteur's explanation of certain facts and appearances belonging to fermentation. In 1861, and since, M. Pasteur has been led by various experiments to divide a group of living organisms into two classes, which he designates *aerobies* and *anaerobies*, the former requiring for their existence

* 'Revue Scientifique,' 26th September, 1874.

and growth the presence of free oxygen, and the latter able to dispense with it, provided they are brought in contact with a fermentable substance from which they can obtain the oxygen they need by a process of decomposition—the latter, he affirms, to be ferments. Septic vibrions he finds killed by free oxygen, and these come under his designation of *anaerobies*. In other cases, and notably in yeast plants, he notices a capability of living in either state; and in the last or *anaerobic* one, they act as ferments.

Before proceeding further with M. Pasteur's researches, it will be well to bear in mind what takes place in the life processes of the higher chlorophyll-containing plants, and we shall then be able to see what relation these *aerobies* and *anaerobies* bear to them.

The experiments and observations of M. Corenwinder, extending and confirming opinions expressed by M. Th. de Saussure, and supported thirty years ago by M. Garreau,* show that the respiratory process of plants is constant, and like that of animals carried on by absorption of oxygen and exhalation of carbonic acid, and that the absorption of carbonic acid with retention of carbon and emission of oxygen is "a veritable digestion." The respiratory acts belong to the nitrogenous matter of the plants, and the carbon digestion to the chlorophyll, and it depends essentially upon the influence of light, being most active during direct exposure to solar rays and diminishing as the light is weakened. The carbon carried off in the respiratory action comes from the supply obtained by the digestive and assimilative processes.

We learn from M. Pasteur that the moulds *Penicillium* and *Aspergillus*, and the "mother of wine," *Mycodermi vini*, are capable of living in either of the states named, and he describes a variety of experiments showing these facts, and he remarks upon them, "We are constrained to admit that the production of alcohol and carbonic acid with the help of sugar, in a word, alcoholic fermentation, are chemical acts connected with the plant life of cells of very divers natures, and that they appear at the moment these cells are no longer able to burn freely the materials of their nutrition by the effect of respiration, that is to say, by absorption of free oxygen, and that they accomplish their life by utilizing oxygenated substances like sugar and combustible bodies, which give out heat in their decomposition. The ferment character then presents itself to us, not as peculiar to this or that being, or this or that organ, but as a general property of the living cell; a character always ready to manifest itself, and actually doing so when its life is no longer accomplished under the influence of free oxygen, or of a quantity of that gas sufficient for all the acts of nutrition." †

M. Pasteur gives drawings of the appearance of various cells

* See 'Revue Scientifique,' 1st August, 1874.
† 'La Bière,' pp. 113, 114.

grown under the two conditions. They might be taken for different species, and no mere microscopic examination would suffice to show what they were.

Speaking of the peculiar effects of yeast and other ferments, he observes that "there is only a slight relation between the weight of the yeast formed and the weight of sugar decomposed; with all other known beings the weight of the nutritive matter assimilated is of the same order of quantity as the weight of the aliments brought into play. The discrepancy where it exists is relatively slight. Such is not the life of yeast. For a weight *a* of yeast formed, the weight of the sugar decomposed is 10 *a*, 20 *a*, 100 *a*, and even more."

The growth and generation of ferments in mineral media are regarded by M. Pasteur as having "a great physiological interest." He says, "They demonstrate, among other results, that all the protein matter of yeasts may have their origin in the vital activity of cells putting in action hydrocarbonous substances without the influence of light or free oxygen—or with free oxygen in the case of the aerobies—together with salts of ammonia, phosphates, and sulphates of potash and magnesia. It might even with rigour be admitted that a similar effect is produced in the higher plants. What serious reason can be invoked in the present state of science for not considering this effect as general? It would not be illogical to extend the results we speak of to all plants, and to believe that the protein matters of plants, and perhaps even of animals, are formed exclusively by the activity of cells acting on the ammoniacal salts and the mineral salts of the sap, or of the plasma of the blood and the hydrocarbonous matters, of which the formation in the higher plants only requires the aid of the chemical forces of green light.

"According to this view the formation of protein substances is independent of the great act of reduction of carbonic acid under the influence of light. . . . As in plant production by a hydrocarbonous matter in a mineral medium, the hydrocarbonous matter may vary greatly, and we comprehend with difficulty how it reduces itself to its elements before serving for the composition of the protein matters, we may hope to obtain as many distinct protein bodies, and even celluloses, as there are hydrocarbonous matters." M. Pasteur states that he is engaged in experiments of this description. He further remarks that if solar radiation is indispensable for the decomposition and formation of the proximate principles of the larger plants, certain lower ones can do without it, and still form a variety of the most complex substances, so that life in inferior forms might exist even if sunlight disappeared.

Objections have been made to M. Pasteur's theory of the action of ferments by various authorities, and the controversy is still going

on in the French Academy. Schützenberger, in his work on Fermentation, says, "Yeast sets up alcoholic fermentation in a solution of pure sugar in the absence of all trace of oxygen, but without developing; this is contrary to the affirmation of M. Pasteur that fermentation is bound up with the organization of the yeast, or is a phenomenon correlative to the vital activity of the cells."

Full explanations on this point are given by M. Pasteur in 'La Bière.' I will cite one passage (p. 239), in which he says, "In order to multiply itself in a fermentable medium, without the presence of oxygen gas, the cells of yeast must be extremely young, full of life and health, still under the influence of the vital activity they owe to the free oxygen which assisted to form them, and which perhaps they have stored up for a time. When older they have much difficulty in reproducing themselves without air, and they age more and more quickly: if they continue to multiply, it is under a *bizarre* and monstrous form. When still older they remain absolutely inert in a medium deprived of free oxygen. It is not that they are dead: usually they rejuvenesce rapidly if sown in the same liquid after it has been aerated."

The lines of inquiry suggested by M. Pasteur may lead to many valuable results. It is obvious that the chemist can compose a great variety of nutrient fluids in which many of the lower organisms can be grown. Certain mineral matters, compounds of ammonia to supply nitrogen, and hydrocarbons that may be varied to almost any extent, offer the means of experiments presenting different conditions and likely to lead to different results.

Unless new methods can be devised, it will evidently be a waste of time to seek amongst the simplest organisms for any transition, or change of dead matter into living matter without the intervention of a living cell; but as the highest organisms are orderly and co-ordinated aggregations of simple ones, the smallest living particle capable of growth, reproduction and decay, may, when rightly questioned, elucidate some of the profoundest problems with which the biologist has to deal.

X.—*Observations on Dactylocalyx pumiceus (Stutchbury), with a Description of a New Variety, Dactylocalyx Stutchburyi.*

By W. J. Sollas, M.A., F.G.S., &c., &c.

(*Read 8th January*, 1879.)

Plates V., VI., VII., and VIII.

The specimens of Dactylocalyx which came under the examination of Stutchbury were two, both of which belonged originally to the Bristol Museum; of these, one, a very fine and complete vasiform example, is still preserved there intact; of the other, which is the describer's type, the Bristol Museum only possesses a part, the other part, comprising a half of the originally vasiform specimen, together with a piece broken from the remaining half, having been exchanged with the British Museum for a half of a specimen of *Hyalonema japonica* (Grey).

Thus there now remains at Bristol a complete specimen of Dactylocalyx, together with a fragment of the type, and having had occasion, while arranging the collection of sponges in the Museum, to examine this material anew, I came across some fresh facts relating to it which appear to me worth recording.

DESCRIPTION OF THE PLATES.

Plate V.

Fig. 1.—*Dactylocalyx pumiceus;* var. *Stutchburyi.* Lateral view. × 0·321.
Fig. 2.—The same, seen from above. × 0·34.

Plate VI.

Fig. 1.—*Dactylocalyx Stutchburyi.* Seen obliquely from below. × 0·37.

Fig. 2.—A lantern-spine, supporting an acerate spicule; the ends of the spicule are not represented in the drawing. × 50.

Figs. 3 and 4.—Similar, but more usual form of lantern-spines, exhibiting their ordinary reticulate character. × 50.

Fig. 5.—Sexradiate spicule, from the surface of the perforating tubule in *D. Stutchburyi.* × 50.

Fig. 6.—Quadriradiate spicules, common in the dermal layer of *D. Stutchburyi.* × 50.

Plate VII. (*Dactylocalyx pumiceus*).

Fig. 1.—Fusiform acerate spicule of the outer surface × 15; *a*, middle of spicule × 150.

Fig. 2.—Sexradiate dermal spicule with distal ray suppressed. × 50.

Fig. 3.—Smaller acerate spicule, capitate at both ends. × 25.

Fig. 4.—Sexradiate dermal spicule, with one of the horizontal arms bent backwards, and all except the proximal ray with capitate ends. × 50.

Fig. 5.—Typical sexradiate of the dermal layer. × 50.

Fig. 6.—Sharply-spined fibre of the secondary network. × 100.

Fig. 7.—Secondary network formed on a framework of large sexradiate spicules. × 50.

Fig. 8.—Dermal sexradiate, with long, wavy, branched rays. × 50.

Fig. 9.—Small sexradiates, from the interior of the body-network; *a*, with pointed, *b*, with capitate ends. × 50.

Dactylocalyx pumiceus (Stutchbury).*

Outer surface.—The under or outer surface of this widely expanded vasiform sponge is folded into a number of ridges and deep grooves, which radiate in an irregular sinuous fashion from the base towards the edge of the vase, the ridges frequently anastomosing laterally in their course, so as to circumscribe the grooves, which thus seldom extend continuously for more than 2 inches in length, and never beyond 2½ inches. The greatest depth attained by these channels is 1⅛″. The exterior of the ridges is marked by circular openings from which more or less cylindrical tubes are continued inwards into the sponge at right angles to its surface; these tubes either open directly into the excurrent canals which we shall mention presently, or more frequently, after branching once or twice, lose themselves in the large meshes of the skeletal network.

On the inner surface of the cup a number of round holes occur, each elongated a little in a radiate direction, looking obliquely

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FIG. 10.—Spicule invested in siliceous material, which has failed to completely invest one ray. At the point where the ray has been left bare it appears to have been reabsorbed, so that its extremity is quite disconnected with the centre of the spicule. × 50.

FIG. 11.—An octahedral node of the young fibre. × 50.

FIG. 12.—Dermal sexradiate spicule. × 50.

FIG. 13.—Sexradiate spicule from the interior of the body skeleton, very similar in size and form to those which furnished the framework of the secondary network in Fig. 7, Pl. VIII. × 50.

FIG. 14.—Dermal sexradiate spicule. × 50.

FIG. 15.—Dermal sexradiate with distal rays pointed and horizontal rays capitate. × 50.

Fig. 16.—Dermal sexradiate with the distal ray reduced to a capitate termination. × 50. *a*, distal ray on a larger scale. × 100.

FIG. 17.—Sexradiate spicule with very long shaft, probably so disposed in the sponge that the horizontal rays projected some distance beyond the dermal surface. × 50.

FIG. 18.—Curved small form of acerate spicule, capitate at both ends. × 50.

FIG. 19.—Two flesh spicules cemented on to the skeletal fibre.

PLATE VIII.

FIG. 1.—Young fibres of *D. pumiceus*, showing their position relative to the dermal spicules. × 100.

FIG. 2.—Dermal layer of *D. pumiceus*, with the acerate spicules omitted. The young fibres are represented in their relative position beneath it.

FIG. 3.—Young fibre of *D. pumiceus*. × 100.

FIG. 4.—A part of the network from the base of *D. Stutchburyi*. × 50.

FIG. 5.—A single mesh of the basal network filled in with secondary fibres. × 50.

FIG. 6.—Young fibres of *D. pumiceus*. × 100.

FIG. 7.—Secondary reticulation of "darning" fibres from *D. pumiceus*. × 50.

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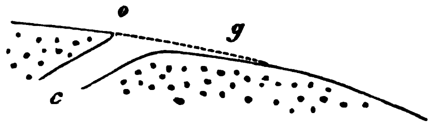
* Stutchbury, 'Proc. Zool. Soc.,' 1841, pt. ix. p. 86; 'Ann. and Mag. Nat. Hist.,' vol. ix. p. 504. Bowerbank, 'Proc. Zool. Soc.,' 1869, p. 77, pl. iii. fig. 1. Carter, 'Ann. and Mag. of Nat. Hist.,' ser. 4, vol. xii. p. 363.

upwards and towards the axis of the cup, and frequently prolonged at the sides into a little gutter, as in Fig. 1.

FIG. 1.



o, oscule; *c*, excurrent canal; *g*, groove.

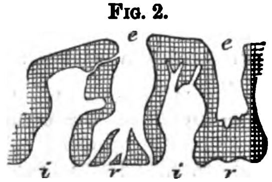
These holes are the mouths of the excurrent canals, which descend into the walls of the sponge, passing especially into the ridges of the outer surface, where, after branching once or oftener, they terminate, either in small round openings on the surface, or by losing themselves in the coarse meshes of the skeleton.

In a similar manner the grooves or gullies of the outer surface are prolonged into tubes which tend towards the inner surface of the cup, ramifying in their course till they open into the excurrent canals, or lose themselves in the large meshes of the skeletal network.

Thus the only connection between the excurrent canals which open on the inside of the cup, and the deep gullies of the exterior, is by means of very minute intervening canals, or through the large meshes of the skeleton.

The ridging and grooving of the exterior, combined with the excavation of the ridges by the excurrent canals, produce a folding of the sponge wall, very similar to that which occurs in the Ventriculites and other fossil sponges. In both cases the folding serves to give great strength to the sponge wall, and a large inhalent surface at a great economy of space.

FIG. 2.



Section across the wall of *D. pumiceus* (⅓ natural size); *r r*, exterior ridges; *i i*, intervening furrows; *e e*, excurrent canals occupying interior of ridge.

The whole arrangement reminds one also of what is seen on a smaller scale in *Halisarca lobularis*, where likewise we have, according to the beautiful sections of F. Eilhard Schultze,* incurrent canals opening externally and branching within into minute canals, which again gather together to form the large excurrent canals that open on the interior of the sponge. Here, however, having a fresh specimen before us complete in all its parts, we can see the ampullaceous sacs on the ultimate ramifications of the incurrent canals, and so understand clearly the mechanism by which water is

* 'Zeitschrift f. wiss. Zool.,' Bd. xxviii. Taf. I. fig. 8; Taf. II. fig. 15; Taf. III. fig. 16.

caused to enter at the inhalent orifices, to pass through the fine canals, and finally to empty itself out of the sponge by the excurrent tubes. But having regard to analogy, one cannot but feel that a similar mechanism once existed in our specimens of Dactylocalyx: the minute canals which unite together the ultimate ramifications of the excurrent and incurrent tubes, were the seat of those ampullaceous sacs which by driving the water continually out at one end of the minute canals, caused a continual influx at the other; the single current entering at one inhalent aperture was immensely subdivided to supply a large number of ampullaceous sacs; the many currents leaving those sacs were united together to flow out at an exhalent aperture in a single stream.

Skeleton.—On examining the skeleton of the sponge with the naked eye, one observes a regular network of fibres, the meshes of which may be called "large" meshes to distinguish them from others of which we speak next; similarly, the fibres may be known as "large" fibres.

Under the Microscope the large fibres are found to consist of a network of much finer fibres, and with correspondingly small meshes. These are what are usually understood as the meshes and fibres of the skeleton, so that the terms may be used without any distinctive qualification.

The large meshes may possibly serve in some cases to give passage to the minute ramifications of the water-canals of the sponge.

Dermal layer.—Bowerbank states that he could not find any trace of dermal structure in the half of the type specimen which he examined, but predicts that when a specimen perfect enough to show it is obtained, it will present the characters of the same structure in *Dactylocalyx Prattii* or *D. Masoni*. Unable to believe that the work of cleaning so large a specimen as ours could have been so thoroughly accomplished as to have removed all vestiges of the dermal skeleton, I set to work to find the missing structure, being at the same time well assured that if found it would *not* in a Hexactinellid sponge like *D. pumiceus* present the same characters as in Lithistids such as *D. Prattii* and *D. Masoni*. Nor did I have long to look, for down in a tubule, which completely perforated the sponge, a perfect forest of long acerate spicules was seen, bristling erectly from the surface, and forming, together with a layer of sexradiate spicules, the structure of our search. This tubule, as already remarked completely perforates the wall of the sponge, passing freely from one side to the other; it thus differs from an ordinary excurrent or incurrent canal, and in all probability represents a part of the surface of the edge of the sponge, which became simply enclosed by growth and not incorporated with the body substance. If this is so,

one will have no difficulty in explaining why a dermal layer was found here and nowhere else—not in a single excurrent canal, nor on the sides of the exterior grooves; although, had it at any time existed in these places, it must almost certainly have left some trace of its existence behind. The truth is, the dermal layer must have been confined to the general surface of the sponge, and covered the walls of our tubule, because these were originally a part of the general surface, and only by accident, as it were, came to assume a tubular form. When the specimen was cleaned the dermal layer would readily be removed from exposed surfaces, but would easily escape destruction in this secluded recess. The absence of a dermal layer from the sides of the grooves on the under surface is most noteworthy, and leads one to infer that the dermal layer on the under surface was continued from ridge to ridge, so as to roof over the intervening gullies without in any case dipping into them.

The piece of the sponge exhibiting the dermal layer was carefully cut out and variously mounted for microscopical examination.

If we commence our observation of a transverse section from its outermost face, we shall see first the distal ends of a number of acerate spicules, which when traced inwards for a distance of about a quarter of an inch, are found to enter, normally to its surface, the skeletal network of the sponge, penetrating through its meshes for about the same distance as they project beyond it. Next we find just outside the skeletal network a dermal layer of sexradiate spicules, each with four long horizontal arms extended in the plane of the dermal layer, and with the two remaining arms at right angles to it, the distal one short and frequently aborted, the proximal one descending perpendicularly into the meshes of the skeleton like a little rootlet into the soil. The horizontal arms do not appear to be arranged into a regular square-meshed network.

Beneath the dermal layer we reach the outermost layer of the reticulate skeleton, consisting of framework spicules only just connected together by siliceous cement. The skeletal layer succeeding this is still very young, so that its fibres still retain an open lace-like character, not having yet become filled up with the siliceous deposit, which subsequently in the third or fourth layers renders them solid throughout. In the third and fourth layers then the fibres have assumed the form of solid homogeneous threads which only differ from those of the quite adult skeleton by their greater smoothness and less abundant tuberculation.

Acerate fusiform spicules (Plate VII., Figs. 1, 3, and 18).—These are cylindrical in the middle and taper very gradually towards each end, till they terminate in extremities of remarkable tenuity. The longest complete example measured $\frac{1}{8}''$ in length and $0 \cdot 0015''$ in breadth; but these dimensions may be slightly exceeded in some other cases, though one cannot say so definitely, owing to the fact

that the great majority of these spicules are incomplete at one end, and thus incapable of exact measurement. In some cases the end has been apparently broken off, in others it appears to have yielded to some solvent action, either after the death of the sponge, or quite as possibly during its life; for the sponge appears to have been alive when first procured, and the eroded umbones of Anodon and Unio shells show that such contemporaneous solution is not an unknown phenomenon in the animal kingdom.

The ends of the acerates are roughened by minute spines, which give them a ragged appearance, and their tenuous extremities are pointed. Associated with them are other acerate spicules (Figs. 3 and 18) which differ in a number of minor characters; thus the latter are usually smaller than the former, more often curved, and though sometimes pointed, yet very frequently capitate clavately at one or both ends. The larger acerates are excavated by a well-defined axial canal which, however, never exhibits any trace of a sexradiate cross in any part of its course. I have repeatedly examined a large number of perfect acerate spicules with a view to making sure on this point, and I am able to state therefore with full confidence that none of them show the least signs of a sexradiate character.* Instead of being aborted sexradiate spicules, they are from my point of view the least modified descendants of the simple acerate spicules of which the early ancestral sponge was composed; the sexradiates on the other hand having departed the most widely from the original type.

The coarse meshes where they open at the surface of the sponge, appear as the circular mouths of minute tubes, walled in with the large fibre, and reminding one somewhat of the structure of *Aphrocallistes*. It is into the large fibre surrounding these tubes, but not into that forming their floor, that the acerate spicules are inserted, which thus leave the tubes unencumbered within, but form a beautiful fringe to them externally.

Sexradiate spicules of the dermal layer.—These are remarkably variable in all their characters; the most typical form being that of Fig. 5, Plate VII. This possesses the full complement of six rays, four lying on the surface of the sponge, one descending into its network, and the sixth projecting distally: the distal ray is short, straight, and rounded off at the end, the other five rays are much longer, more or less curved, and attenuated to very fine pointed extremities. All are minutely microspined for the whole or a portion of their length. The greatest breadth of the rays is 0·0003″.

In other instances we find the distal ray becoming much shorter, frequently capitate (Fig. 16, Plate VII.), and often disap-

* On referring to Mr. Carter's paper (*loc. cit.*) I find that his examination of the acerate fusiform spicules of *Dactylocalyx subglobosa* led him to the same results.

pearing altogether; the horizontal rays, though sometimes capitate, more frequently extending into long sinuous whip-like filaments (Fig. 14, Plate VII.), which often become branched, and thus give rise to such forms as that of Fig. 8, Plate VII. The curvilinear filaments of different spicules intertwine with one another in the dermal surface, giving it a loosely woven texture, like a single layer of cotton-wool filaments: in some cases they touch without uniting, in others they are soldered together at the point of contact.

The branched rays of Fig. 8 cannot be explained by supposing secondary siliceous fibres to have been independently developed in the dermal sarcode, and subsequently to have become united with the spicular rays; these branched rays can only be regarded as a further development of such undulating forms as that of Fig. 12.

Another form of sexradiate is shown in Fig. 18: in this the proximal ray has become excessively long, the horizontal arms remaining comparatively short; Figs. 2 and 4 are similar, but in the latter, one horizontal ray is bent backwards in an elongate S-like curve, and all its rays are capitate, except the proximal one, which is sharply pointed. In Fig. 18 one of the horizontal arms is suppressed, and in Fig. 2 the distal ray; the number of rays suppressed in different spicules is very variable, sometimes both proximal and distal rays disappear, and only the horizontal arms remain forming a simple cross. The microspining of the spicules on the other hand is very constant, but the mode of termination just the opposite, one, two, or three rays, or any number up to six sometimes becoming capitate, the proximal ray, however, usually remaining pointed.

Some of the sexradiate spicules, those for instance with very long proximal rays (Fig. 18) appear to accompany the bundles of acerates which project beyond the dermal surface, their four horizontal arms not being given off in the dermis, but at some distance outside it, after the manner of anchoring spicules.

One cannot but feel some curiosity as to the function of these various spicules, though without actual observation of the habits of the living sponge it seems idle to speculate upon them. The dermal spicules, however, evidently serve to support the dermal membrane of the sponge; the long acerates have probably, as Bowerbank would maintain, a "defensive" action, and it certainly seems just possible that both they and the projecting sexradiates, especially the latter, may serve to capture and secure any minute worms or other animals which in wandering over the sponge should come in contact with their points. Nutritious material would be freed from such animals at every puncture on becoming wounded, and when subsequently decomposition set in, swarms of Bacteria and other organisms would result, and a vast quantity of edible material so be set free to be conveyed by the inhalent currents into

the interior of the sponge. A similar function might perhaps be assigned to the avicularia of the Polyzoa which hold fast for a long while any little victim which may have been caught between their beaks.

First layer of reticulate skeleton.—Notwithstanding a close search was made for them, no instances of framework spicules existing in a free state could be found; they could be seen in the very first stages of cementation, but not earlier: certainly the dermal spicules are very distinct, and never become involved in the skeletal network, unless by rare exception; the acerate spicules likewise, though occasionally involved, as a general rule remain free. In the first stage of cementation we find two or three or more rays of the framework spicules (Plate VIII., Figs. 1, 3, and 6) attached to the rest of the network, from which the spicule seems to have budded forth, the remaining rays projecting freely and usually outwards towards the exterior of the sponge; these free rays are always more or less clavately capitate, and always microspined, although they appear to have already become invested by a thin layer of the ubiquitous siliceous cement. Some of these rays are very persistent, retaining their freedom for a long while, especially those which point directly towards the exterior of the sponge. Near the centre of the attached spicule fine siliceous filaments cross from one adjacent ray to another, subtending the angle formed by them, so that when all six rays have been so connected together, a hollow lantern joint results, which, when regularly developed (Plate VII., Fig. 11), closely resembles the octahedral nodes of *Mylinsia Grayi* or of a Ventriculite. Usually, however, its form is much less symmetrical than this, owing chiefly to irregularities in the form and distribution of the framework spicules themselves, but partly also to the irregular way in which the connecting fibres join them together.

The rays of each spicule are bent in all directions, and the entire spicules are scattered in great confusion, some lying one way, and some another. The rays of adjacent spicules thus exhibit no definite arrangement one with another; sometimes the end of one touches the middle of another ray, and where they touch they unite; sometimes two rays lie parallel to each other at a slight distance apart, then transverse bridges of silica cross from one to the other, and unite them into a fenestrated fibre; frequently one ray traverses the centre of another spicule, and thus multiplies the number of fibres radiating from the resulting node of the finished network.

As the deposition of silica continues, the attached ends of the spicular rays become covered up and disappear, the fenestra of the open fibres are filled in, and solid more or less cylindrical fibres result; so, too, the open lantern of the nodes is in time obliterated,

and the whole skeleton, losing all traces of its original composition, exhibits simply a reticulation of solid fibres radiating from equally solid simple knots. The young fibres are at first smooth, but very early, almost as soon as they become optically simple, they become tubercled, and with age the tubercles increase in number and size.

Secondary rete.—After the formation of the adult network, changes appear to take place in the distribution of the canals of the water-system, by which some of the large meshes become no longer needed as water-channels, and so are gradually filled up by a secondary network, of what might appropriately be called "darning" fibres, from the way in which they seem to mend up the gaps in the aged skeleton. In one case I found this secondary network in a very early stage (Plate VIII., Fig. 7), its component spicules having only just become soldered together by silica, and differing considerably in appearance from the budlike spicules, or pullulating fibres of Bowerbank, which likewise unite into a secondary network. As the secondary fibres thicken with the continual deposit of silica over them, they produce a network of a very different appearance to that of the principal skeleton, its fibres are more rodlike, often sharply and conically spined, less thickened at the nodes, and sometimes more rectangularly arranged. Contrast, for example, Fig. 7, which is somewhat like the network of a *Cypellia* (Zittel), or the spined fibre of Fig. 6 with the excellent figure of the ordinary skeletal reticulation given in Bowerbank's Memoir, plate i., *loc. cit.*

Other spicules besides sexradiates which become involved in the siliceous fibre.—That the large acerate spicules may sometimes contribute to the skeletal network has already been mentioned, but I have never before met with an instance in which a flesh-spicule became so involved. Such a case, however, is shown in Fig. 19, Plate VII., where two flesh-spicules are seen closely attached to the surface of a skeletal fibre: in one the process of envelopment has not gone so far as in the other, so that, although the angles between its rays have been to a great extent filled up, yet its characteristic form is more nearly retained, and the rays attached to the fibre are still so far unenveloped as to allow the light to shine through between them; the other, on the contrary, has become converted into a mere globular tubercle, with the yet uncovered ends of its rays projecting as little spines.

In commenting on the foregoing descriptions, one may first point out the analogy which exists between the rude folding of the walls in *Dactylocalyx* and the more perfect folding in such extinct forms as *Cœloptychium* and the Ventriculites. The resemblance between Cœloptychium and Dactylocalyx appears to be especially marked; in both we have radial ridges and gullies, of about the same size in each; in both the ridges are bifurcated, anastomosed laterally, and marked on the exterior with rounded openings leading

into interior tubes. In *Cœloptychium*, however, all these features possess a regularity which is not to be found in *dactylocalyx;* the ridges in the former sponge are more uniform in size, straighter in direction, and more regular in their bifurcation and anastomosis; the circular openings upon them are also of very uniform diameter, and are arranged at equal distances apart in regular rows.

Notwithstanding these differences of detail, however, an obvious general resemblance exists between the two sponges when their lower surfaces are alone compared, while, as regards general external form, one must allow that Dactylocalyx, especially the variety *D. Stutchburyi*, represents in a striking manner some of the widely infundibuliform specimens of *Cœloptychium*. In other respects more essential differences are to be found.

The character of the nodes in the newly formed network of *Dactylocalyx* may be also alluded to again, since they are always hollow and reticulate to begin with, and not solid throughout as in the later stages of growth; moreover, as already stated, the young node often exhibits an octahedral arrangement in its reticulation, which clearly resembles that of the true hollow-jointed Hexactinellids, and thus passes through a stage which in the latter sponges has become persistent. From this it would appear that in the ancestral form of Vitreo-hexactinellid the nodes were all characterized by a lantern-like arrangement, and that while in some of its descendants the subsequent deposition of silica at the node took place chiefly along the octahedral fibres, and thus gave the Ventriculite knot, in others it followed no definite direction, but simply filling up the interspaces, produced the solid node of such forms as *Dactylocalyx.*

Dactylocalyx pumiceus, var. *Stutchburyi* (Plates V. and VI.)—This form will not require any lengthy description, since it agrees in all important characters with the preceding, and it is only in details of quite trifling value that any difference exists. The general form is that of a vase or flower-basket, but with a much less expanded brim than the type of *D. pumiceus;* its walls are also a trifle thicker than the latter, and the ridges and grooves on its inferior surface are deeper, narrower, and straighter. The elliptical margin of the cup measures 1 foot 1¼ inch along the major axis, and 10 inches along the minor axis. It is 5 inches in height. The surface of attachment, i. e. the base of the pedicel is covered with a layer of denser tissue than occurs elsewhere in the sponge. The fibres of this layer are usually flattened, smooth, seldom tuberculated, and only at intervals connected with the interior body network. Between such points of connection the layer often remains single in thickness, and being flattened and smooth on both faces, presents the appearance of a cribriform plate (Plate VIII., Fig. 4). Sometimes the rounded holes of this plate are filled in with a delicate

tracery of secondary fibres, when it closely resembles the (Plate VIII., Fig. 5) dermal layer of some fossil sponges. The chief fibres of the basal layer are formed on a framework of sexradiate spicules, which may be revealed as casts by boiling in caustic potash; the secondary fibres appear to originate in threads of silicifying sarcode, which have crossed from one side of a mesh to the other. These secondary fibres must not be confused with the secondary fibres of the body skeleton; the latter spin across large meshes, and are moulded on spicules, the former across meshes of the small fibre, and are not deposited on spicules.

The oscules of the inner surface of the sponge exhibit a tendency to elongate into channel-like grooves, following a radiate direction with respect to the axis of the vase, and somewhat resembling the grooves of the under surface, though of much smaller dimensions, never exceeding, for instance, an inch and a half in length.

The openings of the upper surface are so abundantly spined by prolongations of the body skeleton as to give to the whole interior of the cup a rough spinose appearance, which is in marked contrast to the smooth, even surface of the unspined fibres of the under side. In Fig. 2, Plate V., the spines produce round the oscules the appearance of a denticulated margin. They may be obtained readily for microscopic examination by breaking off with a fine-pointed pair of scissors, and catching them as they fall on a spread-out sheet of glazed black paper. Three such spines are represented in Figs. 2, 3, 4, Plate VI. They consist of a prolongation of the skeletal network into a generally hollow reticulate and pyramidal spine, which might be very appropriately named a "lantern-spine" from its rough resemblance to the lanterns used in architecture. The longitudinal fibres of the spine usually become much thicker with age than the rest, as may be seen in Fig. 2, where they have entirely obscured the transverse fibres from sight, if transverse fibres ever existed. The subsequent deposit of silica has, indeed, in many cases so thickened the fibres and modified the original reticulate form as to lead one to doubt whether they were ever modelled on a sexradiate form. A little boiling in caustic potash, however, will soon reveal the imbedded sexradiate spicules, which possess here just the same characters as in other parts of the network. The deposit of silica over them is so thick, however, as to overwhelm them altogether in some cases, as, for instance, in the lateral secondary spine (Fig. 3) projecting from a principal one, which is not represented in the figure, but the direction of which is indicated by an arrow: in this instance we have a conical spine moulded over a sexradiate spicule, and the same thing has taken place in the pointed end of a spine shown at Fig. 4. The spines frequently support one or more long acerate spicules, which pass through and project beyond them like a lance in rest. Now and then these

acerates become involved in siliceous deposit, and form an integral part of the spine.

Similar spines were detected on the upper surface of the type specimen of *D. pumiceus*, but they are much less abundant in it than in its variety *D. Stutchburyi*.

Fig. 3.

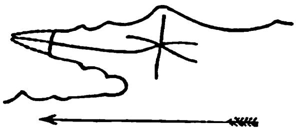


Fig. 4.

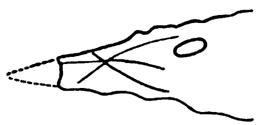


Fig. 3, Lateral spine. Fig. 4, Terminal point of a "lantern" spine × 145. The dotted lines indicate the ends, which have been broken off.

At the bottom of the vasiform cup of *D. Stutchburyi*, at one side, is a cylindrical tube ½ an inch in diameter, obliquely perforating the wall from side to side, and in this, as in a similar tube in *D. pumiceus*, remains of the dermal spicular layer were discovered. A fine collection of the spicules was cut out, but, being blown away by a current of air, was lost, and no subsequent searching succeeded in recovering it. Enough was obtained from what remained, however, to show that the characters of its spicules were the same as those of the dermal layer already described, the projecting acerates and dermal sexradiates both being present; a larger number of dermal spicules, however, were found with distal and proximal rays aborted, the four rays remaining being spread out horizontally in the dermal surface.

By holding the sponge upside down, and smartly tapping the bottom of the pedicel, a large number of long acerates were shaken out; they were generally incomplete at one end, and in a single instance one was observed with the extremity rounded off, thus presenting us with an acuate variety of this kind of spicule.

The relations of the excurrent and incurrent canals could be prettily illustrated by holding the sponge up to the light; looking then into the shaded interior of the cup, one saw illuminated patches opposite the incurrent openings, and these patches always fell on the continuous network of the sponge, never coinciding with an excurrent aperture; when the position of the sponge was reversed, the excurrent apertures similarly cast illuminated images on the surface of the outer ridges, but never coincided with incurrent openings, thus demonstrating the absence of completely perforating canals. Of course the perforating tube previously mentioned is an exception, but then that does not belong to the water-system of the sponge.

XI.—*The Aperture Question.* By J. Mayall, jun., F.R.M.S.

(*Read 8th January*, 1879.)

The question of the existence of apertures, by means of the immersion system, greater than correspond to the maximum possible for dry lenses, has received such powerful support in the affirmative from Zeiss's new oil lenses, that it is almost superfluous to call attention to the position of the discussion. But as the chief exponent of the adverse view still maintains that it is an "undecided question," I will briefly state the most obvious points that occur to me.

It had been asserted by Mr. Wenham that 82° in the body of the front lens is the *limit* beyond which no object-glass can collect image-forming rays. I quote a passage from his writings to show that he has clearly pledged himself that this limit obtains equally in dry and immersion lenses on balsamed objects:—

". . . . the immersion lens . . . . had no property for collecting from a balsam-mounted object a greater number of rays, but that the limit is the same as in the dry lens."

Many passages might be cited conveying the same view.

This is equivalent to asserting the existence of a *natural limit*, depending on twice the critical angle (from glass to air), and, consequently, the impossibility of any objective collecting to a focus a pencil of rays from a radiant in balsam of greater aperture than that which in this medium corresponds to 180° in air. It was to this assertion as regards the *limit* in relation to immersion lenses that exception was taken.

On this question Professor Stokes was urged by me to give a demonstration, and I think it must be admitted that the assertion is thereby refuted as a question of theory. Mr. Wenham admits the validity of the reasoning, but insists that in practical constructions the *limit* of 82° obtains.

Mr. Wenham's views had been brought to definite issue by his published report of his measurement of the aperture of Tolles's $\frac{1}{8}$ immersion lens (owned by Mr. Crisp). The constructor had alleged the lens to be made on a formula by which an aperture was obtained, measured in the body of the front lens (or in a suitably adjusted semi-cylinder—for it is demonstrable that the results are equivalent), 16° beyond the maximum possible for dry lenses,—that is to say, Mr. Tolles claimed for it an aperture in glass of 98°.

Mr. Wenham reported the aperture to be 68° in glass.

The point of interest to me was to prove whether the aperture exceeded 82°.

Passing over some discussions that took place in correspondence, which were not communications to the Society, I may state that I felt under an obligation to place before the Society the evidence I

could adduce on behalf of the original claim that the aperture of the $\frac{1}{8}$ exceeded 82°,—the evidence being Professor Keith's computation of the angle, and the actual measurement by means of Professor Abbe's apertometer which I exhibited at the meeting in June last.

Mr. Wenham's answer to the computation amounts to this:—Because the computed angle is based on the assumption that the radiant is in balsam, therefore it falls to the ground.

Now the question with regard to this lens never was to know if the aperture in the body of the front lens could exceed 82° when adjusted so as to have a front-focus in air. No one had ever alleged such a proposition. All admit that 82° (in glass) is the *limit* for dry lenses, and, of course, all lenses may be regarded as dry if there be a stratum of air between the object and the front lens. The question was, What is the aperture when the lens is adjusted to have a front-focus in balsam? To this Professor Keith's computation answers by tracing the paths of different rays from the back-focus to the front-focus in balsam, and the result (110°) proves that the formula is designed to produce an aperture greater than corresponds to 180° in air,—which was to be demonstrated. Mr. Wenham's criticism upon it is thus seen to be irrelevant.

When the radiant is in balsam, and in immersion contact with the front lens, the critical angle (between glass and air) is no longer a factor in the elements, and can have nothing to do with the aperture, because the rays do not go into air until their emergence at the second surface of the front lens, which is not parallel to the plane front, but deeply curved. With a dry lens, the effective angle of rays from the object in balsam is limited *at the object itself* to 82°—no greater pencil can emerge from the cover-glass. With an immersion lens this limit varies with the immersion medium; with water it is about 126°, with oil the limit depends on the construction of the lens, and may possibly be carried as near to 180° in glass as the present dry lenses approach their limit of 82°. This is a matter for the ingenuity of the opticians.

With regard to the elements furnished for the computation, it is extremely improbable that Mr. Tolles arrived at the precise numerical data by mere guessing; but even in that case, as formerly remarked by Professor Keith, "the force of the result would have been the same."

In confutation of Mr. Wenham's position in the aperture question, we have had two formulæ for immersions placed before us, by which an aperture in the body of the front lens exceeding the *limit* of dry objectives has been traced to the radiant in balsam: the one relating to the $\frac{1}{10}$ (three system) by Tolles in the collection of the United States Army Medical Museum; the other, to the $\frac{1}{8}$ (four system) referred to above; in each of which Professor Keith has

computed the aperture to be about 110°. We have Professor Stokes's authority for the validity of these computations.

As to practical measurements: we have the testimony and report of Dr. Woodward, Professor S. Newcomb, and Professor Keith on behalf of a four system $\frac{1}{8}$ by Tolles. We have Dr. Woodward's report of the measurement of the $\frac{1}{10}$ to which the earlier computation referred; and I exhibited the measurement of the $\frac{1}{6}$ before the Society, with Professor Abbe's apertometer. In all these cases apertures were recorded beyond the limit contended for by Mr. Wenham.

I felt bound to exhibit the actual measurement of the $\frac{1}{8}$ to which the newer computation referred; at the same time I was provided with twelve other immersion lenses by Tolles, Powell and Lealand, and Zeiss, all of which would have afforded similar proof.

I do not attempt to follow Mr. Wenham in his various suggestions for angle measuring. I have found the results obtained with Professor Abbe's apertometer confirmed by a modification of Professor Robinson's plan of measuring (adapted for immersion lenses), and therefore, until Mr. Wenham can show some material error likely to arise from the proper use of the apertometer, I shall continue to regard it as a convenient and reliable appliance.

With regard to the supposed effect of the "outer oblique rays extending to the margin of the field," Professor Keith's computations refer only to the céntral pencil—have nothing to do with any appreciable diameter of field. If apertures be measured by means of a small pencil of sunlight from the eye-piece, the diameter of the field at the front focus is almost inappreciable, and therefore no question can possibly arise concerning "outer oblique rays": this has been done in many cases to test the accuracy of the apertometer method.

NOTES AND MEMORANDA.

Cells, and their Vital Phenomena.—Professor W. Flemming, of Kiel, has published * a detailed account of his extensive researches on the structure of nuclei, and their behaviour during the process of cell-division. The observations were made chiefly on cells from various parts of the body of the larval *Salamandra;* these were examined in the living state, and also after treatment with chromic acid, followed by absolute alcohol, staining with safranin, and clarifying, after a second treatment with absolute alcohol, with oil of cloves. Hæmatoxylin staining of chromic and picric acid preparations was also employed.

According to Flemming, the quiescent nucleus consists of—

1. An investing membrane.

2. An intranuclear network consisting of an extensive system of ramified filaments exhibiting at intervals thickenings or pseudo-nucleoli.†

3. The true nucleoli.

4. A pale ground-substance filling up the remaining space, and devoid of visible structure in the living state, but assuming a granular or fibrillar appearance by the action of reagents.

In the process of cell-division the nucleus passes through the following phases:—

1. The somewhat coarse intranuclear network is converted into a fine-meshed coil, presenting a basket-like appearance.

2. The meshes of the coil become coarser and at the same time looser.

3. The coil assumes a wreath-like form, a space being left in the centre of the nucleus free from filaments.

4. The filaments again advance to the centre, but separate into loops peripherally so as to give the whole nucleus a star-like form.

5. The individual rays of this star undergo longitudinal fission along their whole length, producing

6. Another star-form, distinguished from the first by the extreme fineness of its rays.

7. The star-form disappears, its filaments becoming collected into a plate-like body, situated equatorially across the centre of the cell.

The foregoing are the changes undergone by the mother-nucleus preparatory to division; the following are the stages of the daughter-nuclei. It will be seen that they correspond with those of the mother-nucleus, but occur in an inverse order.

8. The equatorial plate assumes a sort of barrel-shape; a plane across the equator of the barrel is free from filaments, and marks the plane of division of the nucleus; from this plane the filaments radiate, converging slightly, in two directions, or towards the original bounding planes of the equatorial plate.

9. Probably, though this is by no means certain, the filaments

* 'Archiv f. Mikr. Anat.,' vol. xvi. (1878) p. 302.

† This word is employed in a different sense by Van Beneden.

now fuse together in pairs, producing a similar figure to the last, but coarser.

10. The two daughter-nuclei (the two halves of the barrel-form) separate from one another, and each assumes a star-shape.

11. The rays of each star unite and form loops, the wreath-form being the result.

12. The filaments of the wreath become thicker and more closely meshed.

13. As the process of division approaches completion, the coils become finer, and the basket-form is produced.

14. Finally, the ordinary intranucleolar network is produced, marking the completion of the division process and the entrance of the nuclei into a state of quiescence.

Picro-carmine for Cell-nuclei.—In the Report published last August of the Proceedings of the International Congress of Botanists, held at Amsterdam in 1877, is a paper by M. Treub, who drew attention to the use of picro-carmine as a reagent for this purpose. His first step is to kill the cells by absolute alcohol, according to the directions of Strasburger. After making some sections of tissues which had remained in the liquid, the preparations are placed in a 1 per cent. solution of picro-carmine, for a time varying from four to twenty hours; they are then shaken in distilled water in order to dissolve the picric acid, and are placed in a mixture of glycerine and distilled water, which is gradually replaced by pure glycerine containing 1 per cent. of formic acid. After this treatment the nuclei almost always assume a fine red colour, whilst the protoplasm remains entirely uncoloured, which enables the slightest changes which take place in the nuclei to be at once distinguished.*

Influence of the different Colours of the Spectrum on Animals and Plants. — 1. *Animals.*—Observations on the influence of the different coloured rays of solar light upon the nutrition of plants have been more numerous than those on the development of animals. M. Beclard in 1858 experimented with eggs of *Musca carnaria* under different coloured glasses, and found that the eggs developed very unequally, those of the violet and blue rays developing most rapidly, and in the green least.

M. E. Yung† has for three years experimented at the University of Geneva with the eggs of *Rana temporaria*, *R. esculenta*, *Salmo trutta*, and *Lymnea stagnalis*.

The eggs were placed directly after fecundation in vessels which were plunged in solutions coloured respectively violet, blue, green, red, and white, one being also placed in the dark.

The general results were as follows:—

(1) The different coloured rays of solar light act in a very different manner on the development of the eggs of the above animals.

(2) Violet light quickens the development in a very remarkable

* 'Bull. Soc. Bot. de France,' vol. xxv. (1878) p. 129.

† 'Comptes Rendus,' vol. lxxxvii. (1878) p. 998.

manner. Blue comes next, and then yellow and white, which are nearly equal in their effects.

(3) Darkness does not prevent development, but, contrary to the results of MM. Higginbottom and MacDonnell, does retard it.

(4) Red and green light seem to be hurtful, as the complete development of the eggs placed in these colours could not be obtained.

(5) Tadpoles subjected to the same conditions and deprived of food died sensibly sooner in violet and blue light than in the others—they consumed their food store more rapidly.

(6) The mortality seemed to be greater in coloured light than in white light. Nevertheless, as the results have not always agreed on this point, it would be premature to consider this as positively proved.

2. *Plants.*—In 1869 M. P. Bert showed * that certain plants placed under green glass soon died. He thought the explanation was to be found in the green colour of the leaves—to allow none but green light to reach them was to give them what they rejected as useless. Reflecting that these leaves, under a great thickness, appeared red, he thought the plants would die also behind red glass, but was surprised to see that they did not.

This apparent contradiction led him to undertake a further examination.†

If green and red glasses are examined through the spectroscope by diffused sunlight, we see that the red glass intercepts the yellow and all the most refrangible part of the spectrum, only allowing the orange and the red to pass; while the green glass intercepts about three-quarters of the red, starting from the left hand.

The first maintains life, the second kills, and therefore the necessary part of the spectrum is found in this red which the green glass absorbs.

To further determine whether this property is to be attributed to the whole intercepted extent of the red, he compared a solution of chlorophyll, with the green glass, and saw that the part of the red which it absorbed, extended, from left to right, as far as the first absorption band characteristic of chlorophyll (included between the lines B and C), and concluded that it was the part of the spectrum corresponding to this band, which, absorbed by the leaf, was indispensable to its life.

Further experimenting, he found that plants, lighted by a good diffused light, and surrounded with vessels with parallel glass sides containing an alcoholic solution of chlorophyll very frequently renewed, immediately ceased growing, and very soon died: this solution, which was very weak and in a very thin layer, intercepted hardly any but the characteristic parts of the red.

The indispensable part of white light is consequently there, where, moreover, M. Timiriazeff ‡ has recently found the maximum of re-

* 'Comptes Rendus,' 14th February, 1870.
† Ibid., vol. lxxxvii. (1878) p. 695.
‡ Ibid. Sitting of 28th May, 1877.

duction of carbonic acid. If we prevent it from reaching the leaf, the plant being reduced to consume the reserves previously accumulated, becomes exhausted, and finally dies.

But though this part of the spectrum is necessary to plant life, it cannot be said that it is sufficient. Behind red glass, plants live a very long time, no doubt, but they become elongated to excess, and slender, with their leaves narrow and pale-coloured, because they are deprived of the violet blue rays.

Thus every part of the solar spectrum contains portions which play an active rôle in the life of plants. In the most refrangible rays are found those which govern the destruction of tension. In the red are those which determine the tension of the tissues and produce the phenomena of reduction, which are the foundation of vegetable life. Their total, properly proportioned in white light, is necessary for the vital harmony.

It is very probable that these parts utilizable by plants are accurately marked by the different absorption bands of chlorophyll; but to be quite sure, we should have to experiment with luminous spectra, intercepting the different parts by screens, and recomposing by means of lenses. The bad weather last summer did not allow M. Bert to operate with the solar spectrum, and he accordingly made arrangements for using a strong electric light, the results of which have not yet been published.

Colonel Woodward on the Oil-Immersion Objectives and the Apertometer.—Colonel Woodward has examined the $\frac{1}{8}$ and $\frac{1}{12}$ objectives made by Mr. Zeiss, on what Professor Abbe terms the "Stephenson homogeneous immersion system," and thus reports upon them:—

"My first trial by lamplight immediately convinced me of the excellent quality of the $\frac{1}{8}$ and of the surpassing excellence of the $\frac{1}{12}$. On testing them by monochromatic sunlight, using a microscope body with draw-tube, by which I could get ten inches precisely with a range of a couple of inches either way, I speedily satisfied myself that the performance of the $\frac{1}{8}$ fully equalled, while the $\frac{1}{12}$ excelled, the best of the large collection of immersion objectives belonging to the Museum. For photographic purposes the objectives gave similarly satisfactory results.

I find that the saving of time in using these oil-immersion objectives on histological preparations mounted in balsam, and in all similar work, is very great. With water and even glycerine immersion objectives every conscientious worker loses much time with the cover adjustment, and this is entirely economized, while the results, instead of being inferior, are superior to any obtainable with the best objectives made on any other principle."

Colonel Woodward's measurement (by a method of his own) of the aperture of the objectives gave 115° interior angle for the $\frac{1}{8}$ and 114° for the $\frac{1}{12}$. By the apertometer he made the angle of each a little more than 1·25 (numerical aperture). In regard to the scale of the apertometer, Colonel Woodward considers that it has, among other inconveniences, this, that its divisions are too far apart for any very

accurate readings, and that it is to be regretted that it was not arranged so as to read the angle in crown glass (i.e. the interior angle) to degrees. It would have been far more convenient for ordinary use, and just as easy to compute water, air, or glycerine angles from the crown-glass angles as from the ordinary scale.

Professor Abbe, writing to Mr. Stephenson, says that "for the observation of bacteria the oil-immersion lenses are becoming more and more appreciated by German microscopists. There is no doubt your plan which enabled us to get rid of the refractions outside the objective and at the front face, will be considered an important step in the improvement of objectives. In addition to the increase of aperture, the homogeneity of the medium from the object to the first spherical surface turns out to be a great advantage in respect to fine definitions."

Diffraction Experiments with Pleurosigma angulatum.—Colonel Woodward also says, in reference to these experiments,* that though by lamplight he readily observed all the phenomena as described by Professor Abbe, yet on trying by sunlight he obtained different results. The fine longitudinal lines produced by diffraction were distinctly visible on all parts of all the frustules and entirely without limitation to the adherent parts as required by Professor Abbe's theoretical explanation. In the photographs of a frustule in which the adherent parts are comparatively small (laid before the Society at the February meeting), that obtained with the $\frac{1}{8}$ showed the diffraction lines, after the introduction of the diaphragm, on all parts of the frustule without regard to the line of adhesion, while with the one taken with the $\frac{1}{12}$, the same was true for one side of the frustule, the other side being slightly out of focus. A similar diffraction picture of the right side of the frustule could have been obtained, but then the left would have been out of focus, a result of the form of the frustule. In neither case are the diffraction lines limited to the adherent parts. When, however, the illumination was obtained by lamplight the diffraction lines were rigidly limited to the adherent parts.

On these remarks Professor Abbe writes as follows:—

"The fact observed by Colonel Woodward that the longitudinal lines on *Angulatum* appear throughout the whole frustule in observing or photographing with direct sunlight, is not astonishing to me after having considered the distance of those lines more accurately than I had done before. The photographs give this distance (measured in the middle part of *both* photographs) $= 0 \cdot 335\,\mu$ ($\mu = 0 \cdot 001$ mm. $=$ 1 micro-millimetre), the wave-length of D $= 0 \cdot 589\,\mu$, F $= 0 \cdot 46\,\mu$. Therefore the distance *exceeds* the half wave-length even of D, and the lines are, theoretically, within the range of the numerical aperture $1 \cdot 0$ for oblique light. It will thus be a matter of intensity of illumination only, whether they will be visible or not visible through a film of air, and it is quite natural that on the non-adhering parts of a valve they are not visible with lamplight, but yet are visible by direct sunlight."

* This Journal, vol. i. p. 53.

Brain of Invertebrates.—M. Dietl has two important papers on this subject in the 'Proceedings of the Vienna Academy,'* in the first of which he describes the brains of *Eledone*, *Sepiola*, and *Tethys*, and in the second that of *Astacus* and *Squilla*. The former is illustrated by nine plates, the second by one plate. The papers consist entirely of detailed descriptions of the brains in question, and do not readily admit of abstracting. We are therefore reluctantly obliged to confine ourselves to the record of their publication.

Poison Apparatus and Anal Glands of Ants.—Dr. August Forel gives in the 'Zeitsch. für wiss. Zoologie'† an exhaustive account, with two plates, of these structures. He first gives an account of the sting in the *Formicidæ*, stating that in his Section α of that family the organ is quite rudimentary, while in Section β, although very small and delicate, it has all the structure of the sting of *Myrmicidæ* and *Poneridæ*.

Of the poison apparatus, consisting of gland and receptacle, there are two types, one found in Section α of *Formicidæ*, the other in Section β of that family and in all other ants. From this circumstance, as well as from the structure of the sting, Forel proposes to divide *Formicidæ* into two sub-families, *Camponotidæ* (Section α), and *Dolichoderidæ* (Section β). The types are distinguished as (1) poison-bladder with pad (*Polster*); and (2) poison-bladder with knob (*Knopf*).

(1.) In the first type the poison-bladder is elongated and widened and provided with a duct of but little less diameter than itself. Its walls consist of a tunica intima bounding its cavity, then of a layer of protoplasm with scattered nuclei, representing an epithelium, and finally of an outer tunica propria containing muscular fibres. On its dorsal side, between the intima and propria, is a large flattened cushion-like body, the *pad*, consisting of a greatly coiled, branched or unbranched chitinous tube, the coils being separated from one another by a layer of nucleated protoplasm. Although the pad itself is not more than 2 mm. long, the tube may attain a length of 20 mm. At one end the tube opens into the bladder, with the intima of which the edges of the aperture are continuous. At the other end, situated posteriorly or under the duct of the bladder, it is connected with a pair of glandular filaments, lying external to and on the dorsal side of the bladder. These filaments are the free portion of the poison-gland, the coiled tube of the pad with its protoplasm constituting its intra-vesicular portion. The free gland-cæca consist of a layer of epithelial cells, covered by a tunica propria continuous with that of the bladder, and lined by an intima, bounding the lumen, and sending off very fine lateral tubes to the individual gland-cells.

(2.) In the second type the poison-bladder is small and nearly globular, and its duct is a fine tube with walls thrown into transverse folds. The free portions of the poison-gland are shorter and thicker than in the first type; the united portion, answering to the

* 'Sitzungsberichte der (Wiener) k. Akad. der Wiss.,' vol. lxxvii. (1878), 1st Abth. p. 481.

† 'Zeitsch. f. wiss. Zool.,' vol. xxx. (Suppl.), (1878), p. 28.

pad of *Camponotidæ*, pierces the tunica propria of the bladder, losing its own tunica propria, and, pushing the intima before it, hangs free in the cavity, either as a twisted tube with a knob at the end—whence the name of this type of apparatus—or as a mere knob: in either case the whole intra-vesicular portion of the gland is invested by the invaginated intima of the bladder, which takes the place of the tunica propria. At the extremity of the knob is the aperture by which the gland opens into the bladder, and at which the in-turned intima of the latter becomes continuous with the true intima of the gland. The protoplasm of the gland exhibits no cell contours, but only nuclei imbedded in granular protoplasm, the latter being pierced by the fine chitinous offshoots of the intima of the gland. The knob is made of an accumulation of cells, also with chitinous tubules.

In connection with both types of poison apparatus are found accessory glands (*Nebendrüsen*) lying towards the ventral side of the poison-bladder, and answering to the oil-gland of bees and other Hymenoptera. They are unpaired glands, opening by a duct immediately below the opening of the poison-bladder, and may be either simple or bilobed. The wall consists of five layers, an intima bounding the large cavity, a layer of polygonal epithelial cells, one of scattered nuclei, a tunica propria, and a network of fine muscular fibres. The secretion is oily and of a yellowish colour.

The anal glands and anal bladders are stated to have been hitherto overlooked in ants; they are formed by an infolding of the wall of the cloaca between the anus and the pygidium or last outwardly visible tergum. The bladders are two large ovoidal sacs closely applied to one another in the middle line, and uniting posteriorly into a small ampulla from which proceeds the short duct; their walls consist of an intima, a delicate protoplasmic matrix with scattered nuclei, a tunica propria, and a network of muscles. The glands are also two in number, and each is closely applied to the outer wall of the corresponding bladder, into which its duct opens by a large funnel-shaped aperture. The gland-cells are large and spherical, and very easily separated from one another; each contains a large nucleus with many nucleoli, and is supplied with a special tracheal branch. The duct of the gland gives off fine lateral offshoots, one of which proceeds to each gland-cell: on reaching the cell its protoplasmic outer layer becomes continuous with the cell-membrane, while its chitinous intima pierces the protoplasm of the cell, increasing in diameter, and describes several curves, probably ending blindly. Forel ascribes the peculiar smell of some ants (e.g. *Tapinoma*) to the secretion of these anal glands: he has seen it ejected on an enemy.

Parthenogenesis in Bees.—In continuation of the discussion on this subject (see p. 88), M. M. Giard * considers that the true explanation of the observation of M. Pérez is to be found in a supplementary means of nature to assure the reproduction of the immense posterity of the social Hymenoptera. Besides the normal queens, which lay continually,

* 'Comptes Rendus,' vol. lxxxvii. (1878) p. 755.

there are fertile workers, among which copulation is not observable, and is perhaps even impossible for various reasons. They are well proved and frequent amongst the wasps and *Polistes;* to them is attributed, among the drones, the considerable number of males which are observed late in the autumn. They exist among certain species of ants, notably *Formica sanguinea.* Fertile workers have been recognized for a long time among bees; but until recently these fertile workers, as they only laid male eggs, like the drone-bearing queens, conformably to the Dzierzon theory, were thought to be very rare and accidental. They are, on the contrary, frequent, and coexist with the queen in a great number of hives. As in M. Pérez's hive there was a mixture of yellow, black, and hybrid workers, the fertility of certain workers of the two last sorts is sufficient to explain the mixture. An exclusive laying of black drones has even been found in the case of an analogous hive.* More than this, a yellow Italian mother, fecundated, not by a black male, but by a yellow Italian male of her own race, being given, by artificial swarming, to an orphan colony of black bees, not only numerous yellow but also black drones appeared after a certain time. These latter, M. Giard thinks, could only come from fertile black workers; "for, in order to find the black ancestors of M. Sanson, it would be necessary to throw back the atavism into the night of ages, farther perhaps than the bees of Virgil." To decide this question irrefutably, we must employ the method of elimination, and suitably separate the layings of the queen and of the fertile workers.

Hermaphroditism in Perlidæ.—Dr. Alexander Brandt, of St. Petersburg, describes† an interesting case of hermaphroditism in certain of these orthopterous insects (*Perla bipunctata,* &c.), in which he found undoubted ovaries in connection with the testes of male larvæ, both male and female glandular follicles being developed as out-pushings of one and the same excretory duct.

Employment of Mixtures of Chromic and Osmic Acids for Histological Purposes.—Dr. Max Flesch recommends‡ this mixture in the following proportions:—

Osmic acid	0·10
Chromic acid	0·25
Distilled water	100·00

It answers particularly well for the auditory organs of smaller animals, many of the details of structure of the cochlea coming out with quite diagrammatic clearness. The hairs of the hair-cells are, however, mostly lost. It also answers well for examining the growth of bone in the epiphyses of small animals, and for general views of retina, conjunctiva, cornea, and the eyelids; in these latter many details suffer, especially the bacillary layer of the retina.

The objects for examination are placed fresh in the fluid, and kept there from twenty-four to thirty-six hours. There is no need to keep

* See the journal 'Apiculture,' August, 1878.
† 'Zool. Anzeiger,' vol. i. (1878).
‡ 'Archiv f. Mikr. Anat.,' vol. xvi. (1878).

them in the dark, as the osmic acid in conjunction with chromic does not undergo such rapid changes by light as when alone. In the case of cochlea, young bones, &c., a further treatment with 0·25 to 0·5 per cent. solution of chromic acid may be necessary for complete decalcification. The object is then washed and placed in spirit, and the sections may then either be examined in glycerine, or treated successively with absolute alcohol and turpentine, and then mounted in Canada balsam.

The great advantages of this fluid are its rapid hardening properties, and the fact that no further staining is necessary, the osmic acid imparting sufficient colour to the cells, even when mounted in balsam.*

Microscopical Research under Difficulties.—Professor Ray Lankester, writing to 'Nature,' † says that the following short preface to a very valuable account of the stages of development from the egg of one of the centipedes (*Geophilus*), no member of which group had been studied previously to this account, gives so convincing a picture of the enthusiasm for investigation which may animate the modern naturalist, that he extracts it for the encouragement of the "craft."

Elias Metschnikoff has during the past fifteen years worked more assiduously with the Microscope at the observation of the minute details of embryology than any other student. To him we are indebted for our first accurate knowledge of this subject in the case of many important animal forms, e. g. sponges, various jelly-fishes, marine worms, the scorpion, and the book-scorpions, various insects, crustaceans, starfishes, and ascidians. One result has been the injury of his eye-sight. In his memoir on *Geophilus*,‡ he says:—"After having for many years sought in vain for material suited for the investigation of the embryology of the centipedes, I chanced to obtain a quantity of the eggs of *Geophilus*. My find, however, took place under such circumstances, and these interfered so much with my investigation, that I feel justified in describing them more minutely. For some considerable time I had been afflicted with a chronic affection of the eyes, and consequently commenced in the spring of the present year a journey to our south-eastern steppes in order to turn my attention to anthropological studies. Instead of taking with me, as in previous years, all the apparatus necessary for microscopical research, I took this time on my journey only anthropological measuring instruments. When, then, I was in the neighbourhood of Manytsch, nearly in the heart of the Kalmuk steppes, and was visiting a small forest plantation, I discovered quite unexpectedly a number of eggs of *Geophilus* which had been deposited under the bark of a rotten tree-stem where the females were watching over them. I gathered up the precious material, and having packed it carefully in two bottles, set off with all

* A mixture of chromic and osmic acids for embryological purposes was recommended by Dr. A. Milnes Marshall in 'Quart. Journ. Micr. Sci.,' N. S., vol. xviii. (1878).

† 'Nature,' vol. xix. (1879) p. 342.

‡ 'Zeitschrift f. wiss. Zool.' (1875).

speed to Astrachan, in order there to set about the microscopic investigation of the eggs. But when, after four days' travelling, I arrived in a Russian village, Jandiki, near the shore of the Caspian Sea, and inspected my two bottles, I found in them only a couple of dead, opaque eggs, all the others having entirely disappeared. Fortunately I succeeded in Jandiki, where there is also a small plantation, in obtaining fresh material of the same kind, and this I brought in good condition to Astrachan, making the journey by steamboat. In the town of Astrachan I was able to borrow a Hartnack's Microscope from a medical man practising there, and on a second journey took it with me to Jandiki. In this way I was enabled to make out the chief features of the developmental history of *Geophilus* by the use of my less seriously affected left eye. At the same time, in spite of the very favourable character of the *Geophilus* eggs for microscopic research, I could not bring my work to the desired degree of completeness."

Determination and pluck, Professor Lankester adds, have their scope in embryology!

Degeneration of the Visual Organs in Arachnida.—Among the group of pseudo-scorpions, some, such as *Chelifer*, have well-developed eyes, while others, such as *Chernes*, are usually said to be quite devoid of visual organs. The interesting discovery has, however, been made by Anton Stecker, of Prague,* that certain individuals of the latter genus possess eyes, although in a rudimentary condition. In specimens of *C. cimicoides*, Stecker observed on the cephalo-thoracic shield, in the position of the eyes of *Chelifer*, clear, somewhat transparent spots, the chitin forming them being devoid of the granulations covering the rest of the shield. These structures have quite the appearance of corneas, but their visual nature is put beyond question by the remarkable fact that each is supplied by a large and well-developed optic nerve, proceeding from an optic ganglion in connection with the brain. The characteristic anthropod end-apparatus—the layer of crystalline rods—was, however, wholly absent.

About 30 to 35 per cent. of the specimens of *Chernes cimicoides* examined possessed these eye-spots; in the remaining 65 to 70 per cent. they are absent, as well as the optic nerves; while there was only one, or even no, recognizable rudiment of an optic ganglion. It was also made out that the offspring of parents, both of which had eyes, were themselves provided with these organs; but that if either the father or the mother were blind, the young were blind too, having, at most, a feeble indication of optic lobes.

As the author remarks, we have here a most instructive case of the gradual atrophy of an organ by disease, owing to the influence of changed conditions. There can be little doubt that the ancestors of *Chernes* possessed well-developed eyes; the disappearance of the crystalline cones and of the characteristic structure of the cornea seems to have been the first step in the retrogressive process, the optic nerve and ganglion remaining in a fairly well-developed state after the true per-

* 'Morphologisches Jahrbuch,' vol. iv. (1878) p. 279.

cipient apparatus had gone. It is an interesting circumstance that the optic nerve of *Chernes* seems to have, in some degree, taken on the function of a nerve of common sensation, since many of its fibres are distributed to the layer of connective tissue underlying the hypodermis.

In one individual of the same species a curious malformation occurred, there being a single eye in the middle line of the cephalothorax, instead of the usual pair. The organ in question had a slightly convex cornea, divided into hexagonal areas; beneath this was a layer of crystalline rods, and a strongly developed layer of brown pigment. This thoroughly well-formed visual organ is supplied by both optic nerves, which, after leaving the brain, ran forwards parallel with one another, to the layer of crystalline rods.

Two cases of abnormal organs of sight were also met with in *Chelifer ixoides*. In one of these the eye on one side was perfectly normal, but on the other, while the nerves and bacillary layers were well developed, the cornea formed a mere speck, like the eye-spots of *Chernes*. In the second instance, both eyes were developed, but were so small as to be hardly visible; the crystalline rods and pigment, at the same time, were much reduced.

Ascent and Circulation of the Sap.—The course and the causes of the ascent and circulation of the sap in plants are attracting much attention just now among French physiologists, and the results should be carefully studied in connection with the recent researches of M. Boussingault and the Rev. G. Henslow as to the power of leaves to absorb water in the fluid or gaseous state. A recent number of the botanical series of the 'Annales des Sciences Naturelles'* contains three articles bearing more or less directly on this subject. In the first of these, "On the Influence of the Temperature of the Soil on the Absorption of Water by the Roots," M. J. Vesque arrives at the following general conclusions:—

1st. In no case can absorption be practically separated from transpiration, in a plant under normal conditions. As soon as the absorption exceeds the transpiration, the former diminishes, and is probably regulated by the latter; when the transpiration is suppressed, the absorption gradually lessens, and finally ceases. The reason of this phenomenon doubtless lies in the manner of behaviour of the air within the plant. The transpiration ceasing to make a vacuum, there comes a time when the atmospheric pressure, *plus* the pressure from the roots, is incapable of overcoming the tension of the internal air and the resistance of filtration.

2nd. When the temperature of the soil is rapidly raised, absorption diminishes in consequence of the increase of the pressure of the air contained in the wood. For the same reason, absorption increases when the temperature of the soil is rapidly lowered.

3rd. Each temperature of the soil being considered as a constant, the absorption increases with the temperature; except perhaps in high temperatures, where the question has not yet been completely worked out.

* 'Ann. des Sci. Nat.' (Bot.), 3rd ser., vol. vi. (1878) p. 169.

4th. The temperature of the soil has much less influence on absorption than that of the air (by the intermediation of transpiration) under ordinary conditions of moisture. For a much stronger reason, it is of but little consequence for a plant growing in the open air to be exposed to the burning rays of the sun.

The same author follows this paper by one "On the direct Comparison of Absorption with Transpiration." * The principal conclusion to which a long and careful series of experiments has led him, is that the amount of absorption does not bear any direct proportion to that of transpiration; and his general results are summed up as follows:—

1. Of all the theories proposed up to the present to explain the motion of the water in the plant, that of Boehm (referred to hereafter) is most in harmony with observed facts.

2. Although transpiration is the most powerful cause of absorption, these two functions are not necessarily proportional.

3. Absorption is equal (in general terms) to transpiration when the plant grows in average and very slightly varying conditions; for example, in diffused light and in moderately moist air.

4. When a plant removed from these average conditions is exposed to dry air, transpiration is much stronger than absorption. It cannot possibly attain so high a figure as transpiration; the plant withers, and it is exposed to an irreparable disturbance, which consists perhaps in the abnormal destruction of the vacuum existing in the plant.

5. When a plant is removed from these average conditions of growth, and exposed to air saturated with moisture, the absorption, obeying the already existing vacuum, is stronger than the transpiration; but in proportion as the vacuum fills up, the absorption decreases, and finally ceases if the transpiration has also ceased (state of repletion).

6. When a plant lacks water, the suction produced by transpiration is not lost; it accumulates, and comes into operation as soon as the roots come in contact with water. An absorption much more energetic than the transpiration is then observed; but this continues to diminish in proportion as the existing vacuum fills, to be finally regulated by the intensity of transpiration.

The paper by M. Boehm, "On the Causes of the Ascent of Sap," † is a very valuable one:—

Even now, he says, the majority of physiologists consider the movement of the water excited by transpiration in the turgescent cells of the leaves to be a purely osmotic phenomenon. Owing to the continuous production of organic matter in the assimilating cells, the osmotic tension would always have such an intensity that the water coming from the neighbouring cells would replace the loss caused by transpiration. This view is, however, as he believes, erroneous, for the following reasons:—

1st. The movement of water produced by osmose is extremely slow.

* 'Ann. des Sci. Nat.' (Bot.), 3rd ser., vol. vi. (1878) p. 201.
† Ibid., p. 223.

2nd. The cells which directly transpire—those of the epidermis—are generally destitute of chlorophyll; they do not assimilate, and cannot produce matters capable of causing an osmotic diffusion. It is probable that they contain nothing but water, which cannot be concentrated by evaporation.

3rd. If the evaporated water is replaced by the action of osmose, the leaves of the plant which assimilate in moist air would be covered with the water which is given off, and the intercellular spaces would also become filled with water. This has, however, never been observed.

4th. In a green plant exposed in a damp and dark place, the differences of osmotic tension in the cells of the leaves would gradually be effaced by the consumption of the osmotic substances, or by their departure into the stem. The leaves remain fresh when the plant is transported into dry air without permitting access of light.

5th. If the movement of water in the leaves were produced by the differences in density of the contents of the cells, it would act in the same manner in parenchymatous wood, a supposition which will not be maintained.

If the movement of water in the leaves is not due to osmose, this is still more the case with wood, the cells of which in general only contain air when transpiration is very active. Some authorities believed till quite recently that the force of absorption by the roots may have the power of forcing up water even to the topmost boughs of trees. But a considerable number of facts are in opposition to this theory. In a great number of cases it is impossible to prove the existence of any such *vis a tergo*.

M. Boehm, in conclusion, says that, in the parenchymatous tissues filled with sap, the movement of water excited by transpiration is a function of the elasticity of the cell-walls and of the atmospheric pressure, and in cells with rigid walls the elasticity of the wall is replaced by that of the air enclosed in the cells. The presence of a certain quantity of air in the cells of the wood which conduct the sap, far from being a hindrance to the ascent of the sap, is on the contrary an indispensable agent in the production of this movement.

Some have maintained that the ligneous cells of plants in full transpiration contain nothing but air, and that, as no water is seen in them, therefore there is none. But the author pointed out, as much as fifteen years ago, when all micrographers believed the contrary, that the fibres of Coniferæ are closed, and not open. The position of the membrane of the bordered pits evidently depends on the differences of tension in the two adjoining cells, and corresponds to the direction of the current of the sap. The constant presence of a certain quantity of water in the ligneous conducting cells is an undoubted fact.

The movement of the water excited in plants by transpiration is a phenomenon of filtration dependent on the differences of pressure in adjoining cells.

Growth of the Root of Phanerogams.—M. Ch. Flahault has made an elaborate anatomical study of the structure of the apex of

the root in all the important groups of Phanerogams.* The results of his investigations show that the characters of the apex of the root cannot serve for the appreciation of the reciprocal relations of the families, and that the views of M. Treub on the taxinomic importance of these characters are not well founded. Plants most closely allied often differ very much in the structure of the apex of their roots, and on the other hand, plants belonging to widely separated families have common radicular characters.

The structure of the vegetative summit can in fact only serve as regards classification to establish positively whether a plant is a monocotyledon or a dicotyledon.

Removal of Air from Microscopic Specimens.—Much difficulty has been experienced by the working microscopist in removing air from his specimens, especially with wood sections, and various methods have been adopted with greater or less success. One method has been to soak the specimens, after they have been cut, in different fluids for some length of time, such as turpentine, oil of cloves, and the like; these, however, give very unsatisfactory results, sections of wood having lain in oil of cloves for over three years without the air-bubbles having been all removed. Recourse has also been had ineffectually to the air-pump, and microscopists have been at their wits' end to discover some process by which their object can be perfectly and satisfactorily accomplished.

It is claimed† for Dr. Johnson, of Providence, R.I. (U.S.), that he has discovered an effective method. The apparatus he employs is of very simple construction, being a digester, or a common dentist's vulcanizer, the means—steam. The specimens to be thus treated, especially those of wood, are prepared in the usual way, and made ready for mounting. They are next placed in a small vessel of any material which will resist a certain amount of heat. Dr. Johnson uses a small glass phial in his experiments; this is filled up with water after all the specimens, as many as it can conveniently hold, are placed within. A cork can be used, but a slit must be cut in it to allow the escape of air and the admission of steam and hot water. A little water is now poured into the vulcanizer, the bottle of objects placed within, and the lid of the machine screwed air-tight. The whole is then heated to a temperature of about 300° Fahr. for a few minutes. This temperature is sufficient for all practical purposes; a higher degree of heat is unnecessary, or a longer time to remain at the given temperature needless.

When sufficiently cooled the phial is removed, the water drained from the bottle, and alcohol substituted. The specimens are now ready for mounting, or can be bottled and set away indefinitely for use.

This constitutes the whole process; by it the specimens are *absolutely free* from air. Perfect satisfaction is guaranteed; and in every case we are absolutely sure of the results, provided, of course, that the proper care has been taken.

* 'Ann. Sci. Nat.' (Bot.), 6th ser., vol. vi. (1878).
† 'American Naturalist,' vol. xiii. (1879) p. 57.

The *modus operandi* seems to be that the steam penetrates the pores of the wood or other substances, and forces out the air, whose place it takes. The air is then absorbed by or dissolved in the surrounding medium. The woody fibres are not destroyed by the hot and compressed steam, except the soft tissues, as one would at first sight suppose. They are entirely uninjured, and their purposes for microscopic study remain as good as by any other process. Tender specimens in every case must be tenderly treated. This mode of procedure has been followed by several microscopists in America for two or three years, and all the specimens so treated have been remarked for their beauty and excellence.

Immersion Illuminators.—Mr. Wenham thinks that too much is said in favour of the prism which he described in 1856 * (intended to be attached to the under surface of the slide by oil of cloves), by some who take it up as a recent discovery. He at once abandoned it in favour of a lens nearly hemispherical, of about $\frac{2}{10}$ radius, which is much more convenient and effective for all purposes, and less costly. This lens is then attached to the under side of the slide by the oil, in the same way as the prism, or it may be set in a thin plate of brass to be slid under the slide and centred under a low power if necessary; or otherwise mounted in a sub-stage fitting of such a form as not to interfere with the passage of the most oblique rays that can be sent into it sideways, which are by this appliance transmitted straight to the object. When used with a dry objective, the object is seen on a dark field, the rays being reflected from the top of the cover, which acts as a Lieberkuhn.†

In a letter to ourselves Mr. Wenham says that he finds no illuminator equals it, for he can *immediately* bring out *Amphipleura* without the least trouble, even when mounted in balsam; a feat that has sometimes before cost him half an hour's work.

Phosphorescence of the Flesh of Lobsters.—The following view of the cause of this phosphorescence is put forward by Messrs. Bancel and Husson.‡ The first alteration observed in the flesh of marine animals is the formation of a gelatinous substance, and it is then that phosphorescence appears.

Examined under the Microscope, two kinds of germs are seen; on the surface, cells which without doubt produce this kind of mucous fermentation; in the mucus, infinitely small bacteria.

The former, which are of a reddish yellow, are aerobic, and appear to act as plants, that is, that during the day they decompose the carbonic acid of the air, fixing the carbon and setting the oxygen free, which remains in solution in the liquid.

If this liquid contains an anaerobic germ, its development is arrested —it is anaesthetized. But in the night the cell disengages carbonic acid, the germ lives, and the consequences are the destruction of the

* 'Quart. Journ. Mic. Sci.,' vol. ii. (1856) p. 2; and see this Journal, vol. i. (1878) p. 309.

† 'English Mechanic,' vol. xxviii. (1879) p. 501.

‡ 'Comptes Rendus,' vol. lxxxviii. (1879) p. 191.

surrounding matters, with condensation of oxygen on one hand, and on the other the production of carburetted and phosphuretted hydrogen when the medium contains phosphates.

When the oxidizing power of the ferments is considered, it is seen that these hydrogenous products are burnt in proportion as they are formed, and thus the phosphorescence is explained.

All the facts observed prove that the phosphorescence of the lobster is due to an analogous fermentation. This is confirmed by the fact that the ferment of the phosphorescence is destroyed by the putrid ferment in the same way as the vibrions of putrefaction stifle the bacteria of anthrax.

Species of Marine Crustacea in Lake Erie.—At the meeting of the Buffalo Microscopical Club, of the 10th November last, Professor D. S. Kellicott communicated a note on the discovery of a species of marine crustacea in the waters of Lake Erie. He had captured a species of *Mysis* in the hydrant water, thus confirming the previous detection of these creatures in the waters of the great lakes by Stimpson and Hoy.*

It is not stated whether the species is *Mysis relicta*, which is well known to inhabit the fresh-water lakes of Norway and Sweden as well as America.

Professor Kellicott also stated that the body of the *Mysis* was covered with a marine Protozoa, *Acineta tuberosa*, a matter interesting in connection with the fact recently mentioned by Professor H. L. Smith,† of the occurrence of marine forms of diatoms in the waters of the lakes.

Gigantic Isopod of the Deep Sea.—Professor Alexander Agassiz has sent to M. A. Milne-Edwards the crustacea collected by him in December, 1877, from dredgings in the Gulf Stream between Florida and Cuba. Amongst them was an Isopod obtained at 955 fathoms, which was remarkable not only by its relatively enormous dimensions, 9 inches × 4 inches, but by the special arrangement of its respiratory apparatus, which is very different from that of all other known crustacea. M. Milne-Edwards proposes to call it *Bathynomus giganteus*.‡

It would seem that the respiratory apparatus of an ordinary Isopod is insufficient for the physiological wants of *Bathynomus*, and that it requires special apparatus of much greater functional power. The false abdominal feet which ordinarily constitute the branchial apparatus, only form in *Bathynomus* a kind of opercular system under which are found the true branchiæ. These taken separately resemble small branching tufts or plumes growing out of stems which divide more and more and form long hair-like filaments. When examined with a magnifying glass it is seen that they form a certain number of distinct branches more or less developed, and that each of these branches arises from or grows out of a tubular

* 'Amer. Jour. of Microscopy,' vol. iii. (1878) p. 284.
† See this Journal, vol. i. p. 368.
‡ 'Comptes Rendus,' vol. lxxxviii. (1879) p. 21.

peduncle with membranous and flexible walls which soon bifurcate to form other branches; these are resolved into a number of elongated filaments nearly alike, but without regularity, and having the appearance of a spindle with delicate walls.

If some coloured liquid is injected into the sinus at the base of the branchial feet, the whole of this system may be easily filled and the liquid followed not only in the branchial tuft, but also in an irregular network sunk in the thick part of one of the leaflets of the false abdominal feet and comparable to the entire branchial apparatus of the ordinary Isopods. A marginal vessel serves to collect the blood and to send it into the branchio-cardiac trunk.

In all the other Isopods the false abdominal feet are very simple, and wherever they are complex to meet the requirements of a more active circulation, it is by the rudimentary foldings of the posterior plate of these members.

In *Ione* and *Kepon* * branched appendages are found on the sides of the body, but there are fundamental differences between these and *Bathynomus*, not only in the position of the plumes, but in their structure also.

Though inhabiting great depths, the eyes are well developed, each having about 4000 facets, and in place of being at the top of the head they occupy its inferior face, and are placed beneath the frontal margin on each side of the base of the antennæ.

Bathynomus is separated by important characters from all other Isopods, and justifies its being placed in a new family of "branchiferous Cymothoadians."

Limicolous Cladocera.—In the introductory part of a paper on these Entomostraca,† Dr. W. Kurz gives an account of the main difference between these mud-dwellers and their free-swimming congeners. The distinctive characters of the former are due, firstly, to the increased pressure of water to which they are subjected; secondly, to the thickness of the mud in which they live; and thirdly, to the altered relation of the gases absorbed in the water at a considerable depth below the surface. The first two of these conditions give rise to the thick integument and clumsy form which characterize the limicolous species. The carapace is strengthened either by the thickening of its cuticle or by the remarkable circumstance that, at the moult, the old armour is not cast off, but remains superposed on the newer and larger parts beneath, like an old-fashioned "spencer" over a coat; three or four carapaces of progressively increasing size may thus be seen in a single individual. The antennæ of the limicolous forms are comparatively very short and stout, and the setæ on them are not feathered. The whole body has a rounded form, and the brood-pouch is extended laterally, not vertically as in the free forms. As a rule they swim with the dorsal surface downwards. The power of swimming seems to be in inverse ratio to the size of the post-abdomen and the complexity of

* Spelt *Képon* by A. Milne-Edwards; *Kepone* by Adam White; and *Cepon* by Duvernoy.

† 'Zeitsch. f. wiss. Zoologie,' vol. xxx. Suppl. (1878) p. 392.

its armature of spines and setæ. The chitin of the limbs and other parts covered by the carapace is very thin, so that the respiratory surface is much increased. It is doubtful whether this is due to the paucity of oxygen in the medium inhabited, or the thickness of the carapace and its consequent unfitness for respiratory purposes, or because of the exertion of burrowing through the mud which these animals have to undergo. The compound eyes are always much reduced, or may even be entirely absent. At the same time the simple eyes are increased in size and importance, being sometimes larger than the compound eyes, and sometimes having the whole visual function assigned to them.

The remainder of the paper is taken up with a description of the typical genus *Ilyocryptus*, and of its various species, the chief points in the anatomy of which are illustrated in the plate which accompanies the paper.

New Cryptogamic Journals.—In addition to 'Brébissonia,' a monthly journal devoted to Algology,* which first appeared in July last year, and the bi-monthly 'Revue Bryologique,' which has existed for five years, we now have a new journal, published every three weeks, for Fungi—the 'Revue Mycologique,' edited by M. C. Roumeguère, the first number of which appeared in January last. The contents of this number will be found noted in "Bibliography."

Unit of Micrometry.—We stated at p. 353 of vol. i. that the resolution of the Indianapolis Congress, which recommended the $\frac{1}{100}$ of a millimetre as the unit of micrometry, was approved by the New York Microscopical Society. At a subsequent meeting, however, some of the members had the subject reconsidered, and the former approval was unanimously rescinded. The editor of the 'American Journal of Microscopy,' to whose views reference was also made at p. 353, says the action of the Congress "is now generally considered to have been too positive and definite, for the simple reason that the subject had not been sufficiently discussed or considered by the members present."

The Microscopical Section of the Troy Scientific Association have appointed a committee to confer with other microscopical Societies on the subject of micrometry, and that committee, by a circular issued in December last, suggest the appointment of a larger committee (on which each Society should be represented by a member), whose duty it shall be to investigate the questions mentioned below, confer with the Societies and with persons known to be experts in this department, and report to the American Society of Microscopists, at their next meeting at Buffalo in August. They state that their Society, whilst earnestly desiring the success in some practicable form of the movement suggested by the Congress, believe that much further preparation will be required to enable the American Society to take definite action, and that, to prevent the movement being a failure, it must be entered upon after mature deliberation and full consultation, and in such manner as to secure the general and cordial assent of

* See this Journal, vol. i. (1878) p. 368.

those who are prominently interested in and qualified to judge of the subject. To secure the preliminary investigation and the moral power necessary to this end, if the end is now attainable at all, they invite the co-operation of the Societies as above mentioned, as well as of microscopists generally.

The questions are as follows:—

(1) Is it expedient at present to adopt a standard for micrometry?

(2) If so, should the English or the metric system be employed?

(3) What unit within the system selected is most eligible?

(4) What steps should be taken to obtain a suitable standard measure of this unit?

(5) How can this standard micrometer be best preserved, and made useful to all parties concerned? *

M. G. Huberson, the editor of 'Brébissonia,' thinks † it "is sad that a second micrometric unit should be established in the New World, when the Old World has already for a number of years adopted the $\frac{1}{1000}$ of a millimetre as the unit of micrometric measurements, on the proposition of Professor Suringar, of Leyden (Holland)."

The Tomopteridæ.—The interesting pelagic Chætopods ("errant" Annelides) which constitute the two genera of this family, have been investigated by Gruber, Leukart, Carpenter, Claparède, and others. Recently, Dr. Franz Vejdovsky, of Prague, has taken up the subject, and contributes a paper to Siebold and Kölliker's 'Zeitschrift,' ‡ illustrated by two excellent plates, and dealing chiefly with certain points in the anatomy of *T. vitrina*.

1. *Nervous System and Sense Organs.*—There is a great amount of discrepancy between the accounts of the central nervous system given by different authors. Busch described a brain consisting of two united ganglia, but saw no ventral nerve-cord; the latter was described by Gruber and by Kefertein, but Leukart and Pagenstecher saw only the brain, and Carpenter and Claparède described in *T. onisciformis* a single fibre passing from the latter along the dorsal side of the animal, but denied the existence of the ventral cord and circumœsophageal commissures.

The nervous system of *T. vitrina* was investigated by Vejdovsky, both in the fresh condition and after treatment with osmic acid, alcohol, and picro-carmine. The brain is of a somewhat triangular shape, the base being in front; from its anterior angles the tentacular nerves are given off, while from its ventral surface proceed the circumœsophageal commissures, which curve round the gullet, some of their fibres uniting with one another in the middle ventral line, while others are continued backwards into the ventral nerve-cords, a small interval being left between the latter. In this interval lies a longitudinal row of nerve-cells, while another row is situated immediately external to each of the ventral cords, so that there are three distinct rows of nerve-

* 'Amer. Jour. of Microscopy,' vol. iii. (1878) p. 279.

† 'Brébissonia,' vol. i. (1878) p. 80.

‡ 'Zeitsch. f. wiss. Zoologie,' vol. xxxi. (1878).

cells—one median and two lateral—separated from one another by the fibrous cords. The space between the two latter, which is wider above than below, is probably the remains of the primitive medullary groove. The lateral rows of nerve-cells, although continuous, present accumulations at intervals, corresponding to ganglia. These spots are marked in the recent state by patches of violet pigment, from which prolongations are continued along the nerves.

The eyes are seated directly upon the brain; the lens is single, not double as in other species; the pigment is black. The structures situated just in front of the brain, and described as vesicles by Carpenter and Claparède, were only seen in one specimen, and are in reality pits, possibly of a sensory nature, although no nerve-supply was made out to them.

One of the most important points in the paper is the interpretation given by Vejdovsky to the anomalous "rosette-like organs" of the parapodia. One of these is situated near the edge of the fin-like expansion of both notopodium and neuropodium; it is of a bright yellow colour, and consists of five to seven prismatic bodies arranged in a circle. This is all that can be seen in the fresh state; but after treatment with osmic acid, alcohol, and picro-carmine, the yellow rosette is stained black, and the prisms of which it is composed become very distinct, and are seen to be surrounded by a fine homogeneous investing membrane; abutting against their upper ends is seen a convex, highly refracting lens, while at the base of the rosette is a clear roundish area, surrounded by a zone of nerve-cells, from which fibres are given off to the pigment of the prisms. The "rosette-like organ" is thus proved to be a parapodial eye: the animal possesses two of these visual organs to each parapodium, over and above the already known cephalic eyes.

2. *Sexual Products and Seminal Ducts.*—The ova begin as groups of cells formed on the living membrane of the prolongations of the body-cavity into the parapodia. These groups become detached, and float freely in the perivisceral fluid; of the cells of which they are composed, one develops at the expense of its sister-cells, and becomes an ovum. No external aperture for the escape of the eggs was observed.

The seminal cells have a similar origin: the ripe spermatozoa escape from the body by the segmental tubes. These organs consist of a tubular ciliated internal portion, opening into the perivisceral cavity by a funnel-shaped aperture with a rosette-like ciliated border, and of a dilated external portion opening on the surface of the body by a rounded aperture. The dilated half of the tube acts as a vesicula seminalis. In the posterior part of the body the spermatozoa become aggregated into rounded masses (Samenklumpen), devoid of an investing membrane, but mistaken for testes by Carpenter and Claparède.

The paper concludes with a discussion of the various species of *Tomopteris* and *Eschscholtzia*, the two genera of Tomopteridæ.

Abnormal Sexual Organs in the Horse-Leech.—A very curious variation from the ordinary type of generative organs is described by

Dr. G. Asper, of Zurich.* In the horse-leech (*Aulastoma gulo*), as in other *Gnathobdellidæ*, the male organs usually consist of nine to twelve testes on each side of the body, opening into a common vas deferens, which is convoluted anteriorly, forming the vesicula seminalis. From each vesicula seminalis the seminal duct is continued into the base of the single, median penis. The ovaries are two in number, one on each side; each is connected with a short oviduct, which joins with its fellow to form a common canal continuous with the muscular vagina.

The peculiarity of the abnormal form consisted in the fact that the duct from each vesicula seminalis led to a separate penis, so that there were two perfectly distinct intromittent organs, one opening on the twentieth, the other on the twenty-fifth segment. A similar bilateral arrangement existed in the female organs. An ovary was found in the twenty-fifth segment, near the corresponding penis, its duct having a common opening with the latter. A similar female apparatus, consisting of ovary and oviduct, occurred in the thirtieth segment of the opposite side.

The Early Development of Equisetaceæ.—Taking Hofmeister's account of the development of the *Equisetaceæ*, it was very difficult to make out the exact relation between the first stages of the embryo in this group, and the corresponding stages in the other vascular Cryptogams. In Mr. Vines's paper "On the Homologies of the Suspensor," † the horse-tails are purposely left out of consideration in the comparison drawn between the embryos of Phanerogams and of the higher Cryptogams. But the difficulty seems to be quite cleared up by Sadebeck's recent paper,‡ in which the early stages in an *Equisetum arvense* and *E. palustre* are carefully described, and are seen to correspond very exactly with those of, for instance, the fern *Ceratopteris*.

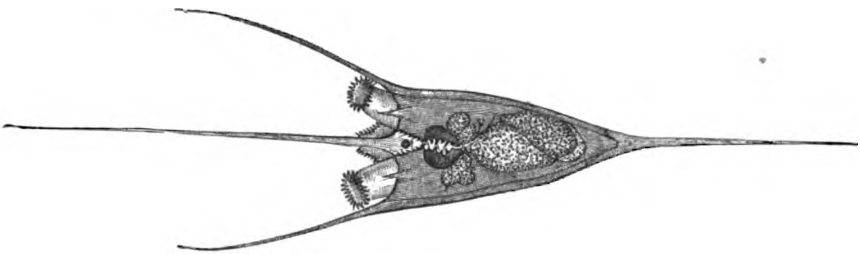
The first septum makes an angle of about 70° with the axis of the archegonium, and divides the oosphore into two cells, an upper, the embryo proper, turned towards the neck of the archegonium, and a lower, the embryophore, the homologue of the suspensor of Phanerogams and of *Selaginella*. Each of these cells is then divided by a septum at right angles to the first, so that four quadrants are produced, the two upper belonging to the embryo, the two lower to the embryophore. Of the former, one becomes the apical cell of the plant, soon assuming the characteristic form of a short three-sided pyramid with convex base; the other becomes the first leaf. The latter, along with the two first segments cut off from the apical cell, forms the first leaf-sheath of the young plant. Of the two lower quadrants, one becomes the "foot," a temporary organ for the absorption of nutriment from the prothallus, the other becomes the first root, an apical cell being formed, from which the base is soon cut off by a tangential septum, producing the root-cap.

A new Rotifer—Anuræa longispina.—Professor D. S. Kellicott, of Buffalo, U.S., has found § a rotifer in Niagara water at that place

* 'Zool. Anzeiger,' vol. i. (1878) p. 297.
† 'Quart. Journ. of Micr. Sci.,' N. S., vol. xviii. (1878).
‡ 'Jahrbücher f. wiss. Botanik,' vol. xi. (1878).
§ 'American Journal of Microscopy,' vol. iv. (1879) p. 20.

having very long formidable-looking setæ, to which he proposes to give the name of *Anuræa longispina*, the long-spined Anuræa.

We have shown the description and drawing to Dr. Hudson, who considers the claim of "new" to be properly made, though the drawing is probably a little "free" as regards the internal organs. Not having seen the animal ourselves, we are, of course, unable to do more than reproduce the woodcut in facsimile.



The description of the rotifer is as follows:—Lorica ovate-cuneate, smooth on both the dorsal and ventral surfaces; it has seven frontal and one terminal spine; the frontal spine situate on the middle of the upper margin is about twice as long as the carapace; seen from above it is straight, from side arched; those at the angles are equal in length to the carapace, curved outwards and downwards; there is a short one on either side of the long central one, also two short ones on the margin of the ventral surface; they seem to form ribs, nearly to the middle, designed to strengthen the ventral plate of the lorica, so that it opens and shuts the front by a hinge-like motion at the middle, similar to the lower shell of a Box turtle; the terminal spine is somewhat longer than the lorica, straight seen from above, cynosuric in side view. The three long frontal spines when highly magnified, always appear rough, like the surface of the carapace of *Ceratium longicorne;* the terminal one is always smooth.

The buccal funnel situated in the lower middle part of the face between the trochal lobes is deep and ciliated; on its upper border is a projecting conical lip well ciliated; these cilia seem to be able to close over the mouth to aid in the retention of the prey. The mallei and incus of the mastax are easily made out, and are of the typical form. Œsophagus short, digestive cavity clearly divided into a capacious gastric expansion, and an intestine, or cloaca. The two glands, one on either side of the œsophagus, are distinct, round in one aspect, oblong in another. Eye large, round, red. Egg attached. Length, including the spines, $\frac{1}{40}$ of an inch; length of lorica, $\frac{1}{170}$ of an inch. The male unknown.

Professor Kellicott seems to have found them at all times, though more abundant in autumn and winter. Like others of the family, the female carries under the posterior part of the body "her unreasonably large ovum, like an old-fashioned hen's egg." The case is so transparent, that it affords a good example for the study of its structure.

When under the compressorium its horns hold it in place so that it may be studied while alive with high powers.

Trichinæ.—At a soirée given at Chicago to the State Microscopical Society of Illinois, Dr. W. T. Belfield and Mr. H. F. Atwood showed some pieces of muscle from rats fed with *Trichinæ*, on a warm stage, with the worms in a living condition moving about. "It is "claimed," says the 'American Quarterly Microscopical Journal,' "that this is the first time that living Trichinæ have been shown in "public. The value of such exhibitions in arousing a public interest "in scientific studies must be very great, and we trust they will become "more frequent." *

Trichina-phobia at Berlin.—For some time past the well-founded fear of trichina has led to a microscopic examination of much of the meat, especially pork, sold in Berlin. Recently the occurrence of this pest there has been more frequent, and Dr. Luetdge, the Director of the Microscopic Aquarium, has consented to give a course of instruction in this branch of microscopy, which began on February 17. The course, with practical exercises, occupies five hours, and is open to ladies and gentlemen at the fee of 5*s.* † The catalogues of opticians at Berlin have long contained as a speciality, "Achromatic Microscopes specially constructed for Trichinæ researches," and accompanied by "an illustrated description of *Trichina spiralis* and its development."

Organogenic Researches on the Capsule of Mosses and on the Embryo of some Polypodiaceæ.—M. Kienitz-Gerloff ‡ has examined *Phascum cuspidatum*, *Ceratodon purpureus*, *Fumaria hygrometrica*, *Barbula muralis*, *Atricum undulatum*, &c. His results are as follows:—

1st. The development of the sporogonium of all the Bryaceæ, and even of *Andræa*, begins, after the preliminary transversal partition of the oogonium, by the formation of an apical cell; the latter originates from the segmentation produced by two septa oblique in opposite directions.

2nd. The growth of the summit of the organ ceases rather early, as soon as the apical cell is divided by periclinic § or longitudinal septa.

3rd. Each segment is divided by a radial septum into two quadrants, inside which the first longitudinal partitions form an *endothecium* which is separated from the surrounding tissue or amphithecium; the endothecium furnishes the columella and the mother-cells of the spores; the perithecium furnishes the wall of the sporangium.

4th. The layer of mother-cells originates on the interior of the endothecium by either primary or secondary partitions; in the former case the internal sporiferous sac is formed after the layer of mother-cells; in the latter, at the same time. The cells of the columella may be transformed into a fertile tissue producing spores.

5th and 6th. The first longitudinal partition which takes place in the amphithecium separates from it the external sporiferous sac, whose

* 'Amer. Quart. Mic. Journ.,' vol. i. (1879) p. 167.
† 'Nature,' vol. xix. (1879).
‡ 'Botanische Zeitung,' 1878, Nos. 3 and 4.
§ That is, convex in the same direction as the periphery.

disappearance then creates between the sporiferous internal sac and the wall of the sporangium the internal cavity of the urn, crossed by filaments which come from the wall.

7th. The peristome belongs by its origin to the amphithecium. The primary number of its teeth is four, corresponding to the four quadrants of the transversal section, in which the radial septa alternate regularly with the periclinic septa.

8th. In the interior of the seta and the vaginula, the cellular partitions follow in the beginning the same laws as the segments which are formed later on; the later partitions become irregular, and trace inside the tissue the first outline of the central cord.

As to the ferns, the author has studied *Pteris serrulata*, an *Aspidium*, *Adiantum cuneatum*, and *Gymnogramma chrysophylla*. He differs from Hofmeister in that he considers, in the quadrant resulting from the division of the oospore, the suspensor of the embryo as coming from one of the cells near to the base of the archegonium, and the root as emanating from one of the cells near to the orifice.* He supposes, moreover, that notwithstanding the fundamental differences which characterize its development, the embryo of the ferns corresponds to that of the mosses. No doubt the first septum is horizontal in the oospore of the mosses, and vertical or nearly so in that of the ferns; but in the opinion of the author that would be owing to a torsion of the embryo of the ferns. This is nothing more than an hypothesis.†

The "Micro-Megascope."—This is the name given by Dr. Matthews to an apparatus that he has devised for exhibiting objects (such as sections of jaws, the foot of a frog, insects, &c.) which are too large to be viewed by the lowest object-glasses, the field of the 5-inch and 4-inch being respectively only $\frac{5}{10}$ and $\frac{4}{10}$ of an inch. They can first be reduced and examined by the apparatus as a whole, and any portion of them may then, by a readjustment of the objectives, be magnified as in an ordinary Microscope. The object is placed before a large condensing lens (on the opposite side being the source of light), and its image thrown upon the mirror, or preferably upon a prism, the reflected aerial image, formed by an objective placed in the sub-stage, being examined by the object-glass as the object. By this means the range of the Microscope is extended illimitably, as the object can be placed at different distances. Dr. Matthews claims that the instrument may rank higher than a "toy," though as a toy it is capable of producing very novel and pleasing effects. His attention was directed to the method by observing the image formed by the areolations in the valves of some of the diatoms, and the eyes of some beetles, and the instrument was described and exhibited by him at the February meeting of the Quekett Microscopical Club, and at the recent soirée.

* These differences depend perhaps on the diversity of the subjects observed. M. Jonkman, who has published in the 'Botanische Zeitung' (1878), No. 9, a study of the prothallus of Marattia, has represented the root as coming from one of the lower cells of the embryo.

† 'Bull. Soc. Bot. de France,' vol. xxv. (1878) p. 121.

Chlorophyll.—M. Timiriaseff, in the Report before referred to of the International Congress of Botanists at Amsterdam, after some reflections on the various methods proposed for treating chlorophyll chemically, states that it is composed of two substances, the one yellow, xanthophyll; the other green, the cyanophyll of M. Kraus, which he proposes to call chlorophylline. This latter, spontaneously decomposing, produces chlorophylleine. Chlorophylline may again be decomposed under the influence of light or mineral acids, and changed into what M. Fremy calls phylloxanthine. Chlorophylleine in decomposing gives phylloxanthine.*

Professor Haberlandt considers that the chlorophyll in the cotyledons of *Phasiolus vulgaris* is formed from starch. The starch granules are gradually surrounded with a layer of protoplasm, which is at first colourless, but gradually turns green, while the starch grains disappear.†

Function of Chlorophyll in the green Planariæ.—Although the presence of chlorophyll has long been recognized in the tissues of a considerable number of Invertebrata, no reply has yet been given to the fundamental question whether it has the same function in the animal kingdom as in the vegetable. Can these animals effect the decomposition of carbonic acid under the influence of solar light with assimilation of the carbon and disengagement of the oxygen?

M. P. Geddes ‡ has experimented on this subject at M. Lacaze-Duthiers' Laboratory of Experimental Zoology at Roscoff, where a species of green Planaria was found in great abundance, which had the habit of seeking and exposing itself to the light like *Hydra viridis*. They were generally found in the white sand in only a few centimetres of water. Placed in a small aquarium, they always sought the side of the light, and when the aquarium was exposed to the sun their movements were much accelerated. After some minutes bubbles of gas, small at first, showed themselves here and there, augmenting in number and volume with astonishing rapidity, equal to that of a green alga under similar circumstances.

The gas can be easily collected by placing the animals in a saucer, covered by another rather smaller turned upside down under the water. At the end of the day the volume of gas is sufficient to fill a small test-tube. If into this tube is plunged a nearly extinguished match, the white incandescence is produced characteristic of diluted oxygen. Ten or twelve of these tubes will collect enough gas to fill the long branch of the bent tube used for approximate analyses. Agitation with the potash solution shows only a trace of carbonic acid, but with the addition of pyrogallic acid the presence of oxygen is completely confirmed by the deep brown colour, and by the ascent of the liquid in the tube.

A series of tests gave 43 to 52 per cent. of oxygen. A similar analysis of atmospheric air, undertaken to ascertain the proportion

* 'Bull. Soc. Bot. de France,' vol. xxv. (1878) p. 129.
† 'Monthly Jour. of Science,' 3rd ser., vol. i. (1879) p. 204.
‡ 'Comptes Rendus,' vol. lxxxvii. (1878) p. 1095.

of oxygen lost by this process, showed a loss of 5 per cent., and it may therefore be said that the gas developed by these animals does not contain less than 45 to 55 per cent. of oxygen, the residue being considered nitrogen.

It is easy to show the extreme importance of the action of light on the life of these animals. Placed in darkness after a journey from Roscoff to Paris, all died in two, three, or four days, whilst others exposed to diffused light decomposed carbonic acid and survived at least two weeks.

Treated with alcohol, the Planariæ give a first solution of a yellow colour, and after that, but somewhat less easily, a solution of chlorophyll of a magnificent green. The residue of the bodies of the animals, coagulated and discoloured by alcohol, boiled in water and filtered, gives a clear solution which treated with iodized water has the deep blue colour, which, disappearing by warming, proves the presence of a considerable quantity of ordinary vegetable starch.

Development and Metamorphoses of Tæniæ.—Thirty years ago Van Beneden, Siebold, Leuckart, and Küchenmeister established, by experiments on carnivorous animals, not only that the vesicular worms were imperfect forms of Tæniæ, but that it was indispensable that the worms should be swallowed by an animal to bring them to the perfect state.

This view, while explaining the origin of the armed Tæniæ of carnivorous and some omnivorous animals, did not, however, explain that of the unarmed Tæniæ of herbivorous animals. The horse, ox, sheep, &c., often have adult Tæniæ, and yet they do not swallow any organism capable of harbouring the scolecides of their Tæniæ.

M. P. Mégnin thinks* he has discovered the key to the enigma from an examination he made of some horses and rabbits. In these animals, the *Echinococci* and *Cysticerci*, when they develop in the adventitious cavities in immediate communication with the interior of the intestine (cavities resulting from the enlargement of follicles or glandules into which the hexacanthian embryos have introduced themselves), or even when they become free in the peritoneal cavity of the wild rabbit, continue their metamorphoses on the spot, and arrive at the adult state without quitting the organism into which they penetrated as a microscopic egg (·03 to ·07 mm. in diameter) either with the food or drink of the animals. In this case, however, they give rise to an unarmed Tænia, whilst the same worm, if swallowed by a carnivorous or omnivorous animal, would become in its intestines an armed Tænia, that is, provided with the hooks of the scolex from which it originates, and which in the former cases it loses.

Some unarmed and armed Tæniæ are therefore two adult and parallel forms of the same worm, and the differences, often very great, which they present (as in the *Tænia perfoliata* of the horse and the *T. echinococcus* or *T. nana* of the dog which originate from the same worm), are due exclusively to the difference of the habitations in which their final metamorphoses are accomplished.

* 'Comptes Rendus,' vol. lxxxviii. (1879) p. 88.

Another Method of Staining.—Dr. A. Lang of the Zoological Station at Naples, having been occupied with the difficult histology of the Turbellaria, and particularly with the nerve-systems of these and other groups of flat worms, found that the method hitherto in use of staining the nerve-tissues was not satisfactory in all respects. It seemed to him to be most desirable to colour distinctly, in the nerve-system, not only the nucleus and the nucleolus, but also the vessels and the protoplasm of the ganglia. Many Dendrocœla with thick basilar membrane proved to be almost totally impervious to distinct colouring. To overcome this difficulty he made several experiments, and found the following mixture (which must of course vary with the nature of the object to be stained) to be beyond expectation:—

50 parts 1 per cent. picro-carmine.
50 parts 2 per cent. eosin (aqueous solution).

The objects, previously hardened in alcohol, are left in the mixture ½ to 4 days, according to their size and their facility of imbibing the colour. Then comes the alcoholic treatment, which is as follows. The picrin is extracted by 70 per cent. alcohol, which must be frequently changed. Then 90 per cent. and absolute alcohol is added, the latter so long as any eosin is dissolved. In imbedding in paraffin the copious use of creasote is much to be recommended.

Dendrocœla stained in this way showed, on making sections, the most distinct colouring he ever obtained, and that for every part, but especially the nerve-system. Nucleus and nucleolus, glands, adipose tissues, &c., appear nearly carmine red, all the rest eosin red.*

Size of Society Screw and of Slides.—At a recent meeting of the State Microscopical Society of Illinois, Mr. Bulloch urged the desirability of adopting a uniform objective screw of larger size than the Society screw now in use, as being essential to the efficacy of low-power lenses of high angle. That the Society screw which has now become an almost indispensable convenience, is too small to admit of efficient work from these lenses, is (says the 'American Naturalist †) a conceded fact, and some makers in the United States who make low powers of enormous angle, have already adopted special screws for them. The uniformity urged by Mr. Bulloch is greatly to be desired and could be easily attained if its importance were appreciated in time.

In an article upon the preparation of rocks and fossils for microscopical examination by R. Fritz Gaertner, in the April number of the 'American Naturalist' for 1878, the advantages of slides measuring 25 × 45 mm., over those 3 × 1 inch, were stated to be as follows:—(1) They can be rotated on the stage, (2) they are less liable to break if dropped, (3) they take up less room. It was also stated that this size was adopted by the New York State Museum of Natural History, and by lithologists and palæontologists generally, both in Europe and America. These arguments seemed to Mr. S. H. Gage

* 'Zoologischer Anzeiger,' vol. ii. p. 45.
† 'American Naturalist,' vol. xiii. (1879) p. 60.

quite as valid as applied to microscopic objects in general; and he therefore adopted this size (25 × 45 mm.) for his own preparations, which he considers have proved very satisfactory indeed.*

The Termination of the Visceral Arterioles in Mollusca.— Thirty years ago Milne-Edwards showed that in different parts of the body of molluscs there were no capillaries, like those in Vertebrata, establishing a continuity between the arterial and venous systems, the blood from the arteries spreading through the more or less irregular spaces called *lacunæ* by Milne-Edwards.

In some molluscs the whole visceral cavity acts as one vast *lacuna*, and if for instance *Arion rufus* is injected by one of the tentacles, the cavity is first filled and then the whole vascular system.

M. S. Jourdain has investigated † the manner by which the arterial blood passes into the visceral cavity in *Arion rufus*.

If there is placed under the Microscope a fragment (cut tangentially) of one of the organs contained in the general cavity, and the external surface is examined under a power of 200 to 250 diameters, it is seen that the final ramifications of the arteries (the diameter of which is variable) all reach the free surface of the organs, and that there they terminate abruptly by a truncated and wide-mouthed extremity. It is by these orifices, nearly always widely funnel-shaped, that the arterial blood passes into the general cavity.

This curious anatomical disposition seems to have been observed by Alder and Hancock, though its true signification escaped them.

M. Jourdain thinks that the orifices of the so-called aquiferous vessels of the Acephala and other Molluscs are of the same nature as the arterial openings above described.

Hæmocyanin a new Substance in the Blood of the Octopus.— M. L. Fredericq has discovered ‡ in the liquid part of the blood of *Octopus vulgaris*, a colourless albuminoid substance which he calls hæmocyanin (*αἷμα*, blood, and *κύανος*, blue) as it forms with oxygen a combination of a deep blue colour. A vacuum, or contact with the living tissues, is sufficient to drive off the oxygen.

This substance plays the same part in the respiration of the *Octopus* as hæmoglobin does in that of the Vertebrata. It is charged with oxygen in the branchiæ of the animal, and then going into the arterial system and the capillaries, it gives up the oxygen to the tissues. The venous blood is colourless, and the arterial blood a deep blue. These changes of colour are clearly due to the fact of respiration, as may be demonstrated by laying bare the great cephalic artery. The blood is seen to be blue while the animal respires normally in the water, but if the respiration is impeded by the animal being taken out of the water or by introducing the fingers into the pallial cavity, the arterial blood loses colour and takes a pale

* Mr. S. H. Gage, in 'Amer. Quart. Mic. Journ.,' vol. i. (1879) p. 160.

† 'Comptes Rendus,' vol. lxxxviii. (1879) p. 186.

‡ Ibid., vol. lxxxvii. (1878) p. 996, and 'Bull. Acad. Roy. de Belg.,' vol. xlv. (1878).

asphyxiated tint. The same takes place if the respiratory muscles are paralyzed by the section of the pallial nerves.

Hæmocyanin appears to be the only albuminoid substance in the blood, as is proved by the method of successive coagulations by heat. It is easy to isolate; being the only colloid substance in the blood, it is sufficient to subject the plasma of the blood to an energetic dialysis for three or four days so as to eliminate completely the salts and other diffusible substances. The liquid is then filtered and evaporated at a low temperature, when a blue brilliant substance is obtained in appearance like gelatine. It becomes blue in contact with oxygen, but colourless in a vacuum; coagulates in clots by heat, alcohol, ether, tannin, the mineral acids, and the greater part of the salts of the heavy metals. It burns with an odour of burnt horn and leaves a residue so rich in copper, that the blowpipe at once establishes its presence.

The copper seems to be in the same state as the iron in hæmoglobin and it plays an analogous part. Hæmoglobin may as is known be decomposed into ferriferous hæmatin and a coagulated albuminoid substance not containing iron. Hæmocyanin gives the same reaction. M. Fredericq has not yet been able to determine the proportion of copper or the proportion of oxygen with which it combines.

Chromatic Function in the Octopus.—M. Fredericq also finds * that the changes of colour in the skin of the octopus do not generally correspond to mimetic facts, but might rather be classed with the changes which the vasomotors produce in the human face. They express the different emotions, especially anger or fear.

A quick movement made before an octopus quietly breathing in the aquarium, renders a black spot immediately visible on the two extremities of the pupil, which dilates. The phenomenon disappears almost as quickly as it appeared. If the animal is excited still further, it gets into a great fury; its whole body assumes a dark colour, and the papillæ of its back bristle up. These changes of colour depend upon the central nervous system. The section of the nerve which goes to the muscles of the chromatophores is enough to paralyze the latter, and to bring on the passive phase of withdrawal of the chromatophores. That part of the skin served by the nerve immediately becomes pale, and then presents the minimum of coloration.

The excitation of the peripheral end of the nerve cut has precisely the contrary effect. In this case, all the chromatophores which depend upon it are brought into the condition of expansion, in consequence of the contraction of the radiating muscles; and the corresponding part of the affected surface presents the maximum of coloration.

Owing to their superficial situation and extended distribution, the pallial nerves are extremely well adapted for the demonstration of these facts.

In the normal state, the octopus generally presents a tint of medium intensity; the dilator muscles of its chromatophores are in a

* 'Comptes Rendus,' vol. lxxxvii. (1878) p. 1042.

state of *tonus*, or continual semi-tension. This state gives place to a relaxation of the muscles as soon as the nerves are cut; these latter then continually transmit to the periphery a certain amount of nervous influence, emanating from the nervous centres. The physiological centre of these movements of the muscles of the chromatophores is in the sub-œsophageal nervous mass, for the ablation of the supra-œsophageal mass does not produce the decoloration.

The contractility of the dilator muscles of the chromatophores may also be set in action by irritating the skin (after the section of the nerves) by electricity, heat, or a drop of acid, or by mechanical friction, which produces a dark spot.

The action of a very bright light has an entirely opposite effect; it makes those portions of the skin on which it acts grow pale.

The dark-coloured phase, therefore, represents the condition of activity of the muscles of the chromatophores. The phase of decoloration represents the passive condition of withdrawal of the chromatophores.

The results of these experiments thus establish the accuracy of the generally admitted conception of the histological structure of the chromatophore, and confirm the muscular nature of the radiating fibres of these elements.

New Classification of Thallophytes.—The classification of Thallophytes recently promulgated by Sachs,* is considered by Dr. G. Winter † to be unsatisfactory in many points. Independently of minor details, such as the location of *Volvox* among Zygosporeæ, of Characeæ among Carposporeæ, &c., he objects to the main principle of the classification, the abolition of the hitherto recognized classes of Algæ and Fungi, and the establishment in their place of four classes of Thallophytes, each consisting of a series containing chlorophyll, and one destitute of it. It is impossible to maintain in many cases a near genetic connection between groups placed by Sachs in two series of the same class; as, for instance, between Zygnemeæ and Mucorini; *Vaucheria* and *Peronospora*; Florideæ and Ascomycetes, &c. He considers the fundamental error, both in this classification and in that proposed by Cohn, to consist in laying too great stress on a single character, the mode of reproduction, to the exclusion of others; and proposes to retain the primary classification of Thallophytes into Fungi and Algæ. The former he divides into Schizomycetes, Saccharomycetes, Myxomycetes, Zygomycetes, Chytridiaceæ, and Oomycetes (Basidiomycetes and Ascomycetes); the latter into Cyanophyceæ, Chlorosporeæ (including Pandorineæ, Conjugatæ, *Vaucheria*, Volvocineæ, Œdogonieæ, *Coleochæte*, &c.), Fucoideæ, and Florideæ. The Basidiomycetes are divided into six families:—the Entomophthoreæ (reproduced by basidiospores with secondary spores, and gonidia or gemmæ), Ustilagineæ (spores and sporidia, as well as conidia), Uredineæ (teleuto-spores and sporidia, as well as conidia or *Uredo*), Tremellineæ (basidiospores with sporidia, and spermatia or

* 'Lehrbuch der Botanik,' 4th ed., p. 248; see also Thiselton-Dyer, in 'Quart. Journ. Micr. Sci.,' vol. xv. (1875) p. 295.

† 'Hedwigia,' 1879, p. 1.

conidia), Hymenomycetes (basidiospores and conidia), and Gastero-mycetes (basidiospores, and gemmæ or portions of the mycelium). While the Fungi attain their highest development in the Ascomycetes, the Algæ pass on, through Characeæ, to the Muscineæ.

Fungoid Diseases of Plants.—*Disease of Chestnut Trees.*—M. J. De Seynes (in continuation of a paper by M. J. E. Planchon, previously published *) describes a disease which attacks the roots of chestnut trees.† The parasitic mycelium, which is analogous to that of certain Dematiei or *Zasmidium cellare*, forms a superficial network, and also one which penetrates the tissues and destroys the cellular layers which are the richest in protoplasm, the fibres of the liber and the woody fibres not being attacked. One of the symptoms of the action of the parasite is that the growth of the young radicles longitudinally is arrested, but the diameter increases, so that they ultimately form olive-like bodies, attached to the parent branch by pedicles.

In a subsequent paper,‡ M. Planchon, referring to the doubts he had expressed as to the species of fungus which the mycelium which attacks the trees gives rise to, states the reasons which "lead him to suppose to-day that the agaric in perspective is almost certainly *Agaricus melleus* of Vahl."

Fungus Disease in Lettuces (*Peronospora gangliiformis*, Berk.).—Lettuces have been invaded for some years, in France, by a disease which impedes the development of the plants, and spots and dries up the leaves. The havoc has been so considerable that a small body of market gardeners have offered a prize of 10,000 francs to whoever will put a stop to it.

M. Max Cornu has found § that the disease is produced by a parasitic fungus (*Peronospora gangliiformis*, Berk.), which frequently attacks other plants, groundsel, and especially the artichoke, where the disease is hidden by the down of the leaves. It gives rise on the inferior side of the leaves to whitish mealy tufts, whence the popular name of "meunier" (miller).

In tearing off a strip of the epidermis of a lettuce attacked, we observe conidiophorous filaments, issuing through the opening of the stomata, as in other species of the fungus. They are in groups of two or three, or single; their superior part is variously ramified; the whole presents the appearance of a little tree. The little branches are dilated at their extremity, and bear from three to six sterigmata, which give rise to the conidia. These are broadly oval, with an incomplete papilla; the germination gives rise to a filament sometimes torulose in a remarkable manner.

The gardeners attribute the malady to the west winds, and to rainy and mild weather; it may be understood by this that these conditions favour the dissemination and germination of the spores on the young plants, for it cannot be a question of spontaneous generation.

* 'Comptes Rendus,' vol. lxxxvii. (1878) p. 583.
† Ibid., vol. lxxxviii. (1879) p. 36.
‡ Ibid., p. 65.
§ Ibid., vol. lxxxvii. (1878) p. 801.

When a crop of lettuces is suddenly invaded by *Peronospora*, where must the cause of it be sought? The cause ought to be attributed to the surrounding weeds, to the groundsel, artichokes, &c., already having the parasite. Sometimes, however, none of these plants are found in the neighbourhood: the spots are then produced by the germination of dormant spores or oospores, the second manner of reproduction of the parasite—oospores which germinate after a long time of repose, and may be preserved in the soil or on its surface, only requiring a little damp and heat in order to germinate.

These oospores are developed in the tissue occupied by the filaments of the mycelium, and dried up under its action. They are frequent upon groundsel, but very rarely appear on the lettuce, although their existence there is most probable.

If a transversal section is made of the leaf attacked, we see the mycelium creeping between the cells, and putting forth elongated ovoid suckers: when the exhausted tissue dies the mycelium disappears, and is itself the cause of its death. It is this change which is met with during the summer.

If the plant is more completely invaded, the conidiophorous filaments are more rare on the surface of the leaf, which is paler, and the leaf dies entirely without drying up; it grows soft, and turns brownish. This modification is generally produced outside the external leaves; and it is this which is found during the winter.

M. Max Cornu considered it possible to find in the cultivation of the plants and in the history of the parasite a means of guarding against its attacks; and presented to the Academy later some general considerations on the subject.*

Disease of the Coffee-tree originating from Anguillulæ.—A disease has made its appearance in Brazil which rapidly kills the coffee-tree, an apparently healthy tree dying within a week from its leaves withering and falling off.†

On examining the roots of the trees they are found to be completely covered with swellings the size of hempseed, the root presenting the general appearance of a vine attacked by the Phylloxera. These swellings contain cysts with hyaline walls, which in their development destroy the fibro-vascular structures. Within the cysts are a number of ovules in all stages of development; those in an advanced stage are somewhat reniform, with a hyaline enveloping membrane, and within them is found coiled up a small *Anguillula*, about ·25 mm. long, and without any trace of sexual organs. Each cyst contains from forty to fifty ovules, or about 30,000,000 *Anguillulæ* per tree.

The animalcules, which are not reviviscent, when developed escape out of the cyst, leaving the cavity open, and the roots soon rot and are invaded by cryptogams.‡

* 'Comptes Rendus,' vol. lxxxvii. (1878).

† M. C. Jobert, in 'Comptes Rendus,' vol. lxxxvii. (1878) p. 941.

‡ See also a paper by the Rev. R. Abbay, on "*Hemileia vastatrix*, the so-called Coffee-leaf Disease of Ceylon," in 'Jour. Linn. Soc.' (Bot.), vol. xvii. (1878) p. 173.

Organization of Hygrocrocis arsenicus, Bréb.—This cryptogam was gathered for the first time in 1836, and presented to the 'Académie des Sciences' by Bory Saint-Vincent, who referred it to the genera *Hygrocrocis* or *Leptomitus*, which de Brébisson confirmed by naming it *Hygrocrocis arsenicus*. In 1841 Louyet found it again in Belgium. Since then, although all druggists might have seen it in their bottles of arsenical preparations, it has not attracted any attention.

M. L. Marchand has recently studied it as developed in "Fowler's solution," and thus describes it:*—The invasion of the solution commences as an opaline cloudiness in suspension in the liquid. This cloudiness, examined under the Microscope, presents the appearance of a glairy mass containing brilliant points, fine dust, whose particles are so minute that they cannot be measured.

Later on, the spot increases and becomes coloured in the centre. The periphery remains glairy, but the centre (the oldest part) shows globules in tubes, whose walls, with age, become less undecided. These tubes are ramified, and then their contents become homogeneous. In proportion to their age the formation of septa takes place. The septa, at first widely separated, approach each other in such a manner that the dimensions of the cells become equal in all directions.

At first the mass remains opaline and floating in the liquid if the bottle has not been shaken; later on the cloudiness becomes dark towards the centre, and at last presents a brownish point, which increases and reaches the periphery; the opaline portions are invaded, and the mass, become brown, is precipitated at the bottom of the bottle. Examined under a low power, it resembles a little chestnut from 1 to 3 mm. in diameter, bristling with points. These points are the extremities of filaments, which for the most part have become torulose, knobbed and irregular, and some moniliform. From their protuberances start fresh filaments which ramify, or little blisters, which are hyaline and pyriform. The mass becomes more and more brown, and at last completely black; the plant is now in fructification.

If the elements which compose it are examined at this stage we find—

1st. That the filaments of the periphery are elongated inordinately into hyaline tubes, which terminate in a glairy mass, which envelops the organism and forms a cloudiness round it which resembles the cloudiness which first appeared; in this network and glairy mass float spores, and the debris of various organs.

2nd. That all the filaments of the centre have assumed new forms. The torulose moniliform filaments have increased and become almost entirely black. It is impossible henceforth to see their contents; they disarticulate with extreme facility, and the knobbed irregular filaments disarticulate with the same facility. They are less dark in colour, but the pyriform blisters which they have formed have become sporangioles of a very dark hue, particularly on the side of the point which attaches them to the filament; at their opposite part, which is

* 'Comptes Rendus,' vol. lxxxvii. (1878) p. 761.

swollen, they open by a dehiscence into two lips, and from each escapes from two to three colourless hyaline spores, evidently provided with a membrane. The extremities of these same filaments, which have remained regular, and whose cells are rectangular, and more or less elongated, terminate by bunches of spores, some rounded and arranged in umbellated rows around the superior cell; others, elongated into rods which become smaller and smaller in proportion as we approach the extremities, are in ramified bunches. Both resemble *Spicaria*.

We ought perhaps to class among the means of reproduction some bodies met with in fewer number than the preceding: they are larger than the spores of the sporangioles, are reticulated on the surface, and marked with a star, generally with three points; most often they are found free; in one case one of them seemed to be carried by a filament, and it seemed embraced at its base by two branches which were curved towards it.

M. Marchand draws the conclusion that *Hygrocrocis arsenicus*, formerly placed amongst the Algæ, is a fungus belonging to the Dematiei; a practical confirmation of opinions given *a priori* by Decaisne, Bornet, Van Tieghem, &c.

The "Plastids" of the lower Plants.—M. E. Hallier has published a book on this subject, in which he deals with the parasitic diseases which attack the potato and the cabbage butterfly. The author dwells at length on *Peronospora*, which in his opinion is not a real parasite, but a saprophyte. He asserts that he has seen Bacteria and Vibriones originate from the *plastids* of *Peronospora*. He gives the name of *plastids* to the accumulations of protoplasm which are formed not only in the conidia, but also in the interior of the mycelium of this cryptogam. In his opinion the contagious character of the disease, and the cause of the alterations, are to be found in the existence of these agents of putrefaction, Bacteria or Vibriones. He has also studied another disease of the potato, which he thinks is due to *Pleospora polytricha*, Tul., although he has not proved by actual experiment that it is actually this *Pleospora*, a parasite on grasses, and moreover rare in Germany, which penetrates into the soil and thence into the tubercules of the potato to cause this disease. A very common Lepidoptera, *Pieris Brassicæ*, is attacked by two diseases, a kind of *muscardine*, and a kind of *gattine*. The former is contagious, and is apparently reproduced by the conidia arising at the extremity of the filaments which have passed through the body of the insect. The second is caused by one of the Torulacei, and the author thinks that here again the contagion and disorders are not due directly to the joints of *Arthrococcus*, but to *Micrococci* developed in the plastids of this *Arthrococcus*.*

Staining for Fungi.—Dr. W. Hassloch has obtained excellent results in the examination of fungi by using gold chloride as a staining fluid. He employed a one-half per cent. solution, which stains

* 'Bull. Soc. Bot. de France,' vol. xxv. (1878) p. 66.

in from one to six hours, and the specimens were mounted in diluted glycerine.*

Spines of Echini.—The last published part of the 'Transactions of the Royal Irish Academy'† contains a memoir by Mr. H. W. Macintosh, B.A., on the structure of the spines in the sub-order of the Desmosticha (Haeckel). In indicating four series into which, judging from the structure of the spines, this sub-order may be divided, the author expresses his opinion that the characters derived from the spines are just as useful as any other characters drawn from the comparison of individual parts. He finds it just as easy and as certain to recognize a Diadema, an Echinus, or an Arbacia by the structure of its spines, as by the arrangement of its pores or the disposition of its anal or genital plates. The paper is accompanied by three plates containing twenty-seven figures, all drawn by the author with the assistance of a Wollaston's camera lucida. The figures represent transverse sections of primary inter-ambulacral spines of some twenty-six species, and have been drawn on stone by Tuffen West with great care and accuracy.‡

The Locomotor System of Medusæ.—Mr. G. J. Romanes has concluded his observations on this subject, which were communicated to the Royal Society in a paper read in January last.§

The principal bulk of the paper is devoted to a full consideration of numerous facts and inferences relating to the phenomena of what the author calls "artificial rhythm." Some of these facts have already been published in abstract,‖ and to explain those which have not been published would involve more space than it is here desirable to allow. The tendency of the whole research on artificial rhythm, as produced in various species of Medusæ, is to show that the natural rhythm of these animals (and so probably of ganglio-muscular tissues in general) is due, not exclusively to the intermittent nature of the ganglionic discharge, but also in large measure to an alternate process of exhaustion and restoration of excitability on the part of the responding tissues—the ganglionic period coinciding with that during which the process of restoration lasts, and the ganglionic discharge being thus always thrown in at the moment when the excitability of the responding tissues is at its climax.

Light has been found to stimulate the lithocysts of covered-eyed Medusæ into increased activity, thus proving that these organs, like the marginal bodies of the naked-eyed Medusæ, are rudimentary organs of vision.

The polypite of *Aurelia aurita* has been proved to execute movements of localization of stimuli somewhat similar to those which the author has already described as being performed by the polypite of *Tiaropsis indicans*.

Alternating the direction of the constant current in the muscular

* 'New York Medical Jour.,' Nov. 1878.
† Vol. xxvi. (Science), Part 17.
‡ 'Nature,' vol. xix. (1879) p. 319.
§ 'Proc. Roy. Soc.,' vol. xxviii. (1879) p. 266.
‖ 'Proc. Roy. Soc.,' vol. xxv. p. 226.

tissues of the Medusæ has the effect of maintaining the make and break stimulations at their maximum value; but the value of these stimulations rapidly declines if they are successively repeated with the current passing in the same direction.

In the sub-umbrella of the Medusæ waves of nervous excitation are sometimes able to pass when waves of muscular contraction have become blocked by the severity of overlapping sections.

Exhaustion of the sub-umbrella tissues—especially in narrow connecting isthmuses of tissue—may have the effect of blocking the passage of contractile waves.

Lithocysts have been proved sometimes to exert their ganglionic influence at comparatively great distances from their own seats—contractile waves originating at points in the sub-umbrella tissue remote from a lithocyst, and ceasing to originate at that point when the lithocyst is removed. A nervous connection of this kind may be maintained between a lithocyst and the point at which the waves of contraction originate even after severe forms of section have been interposed between the lithocyst and that point.

When the sub-umbrella tissue of *Aurelia* is cut throughout its whole diameter, the incision will again heal up, sufficiently to restore physiological continuity, in from four to eight hours.

Tetrapteron volitans.—This peculiar marine hydrozoon was imperfectly described in 1851 by M. Busch, who named it *Tetraplatia volitans*. It has now been re-discovered by Professor C. Claus, who gives it the name at the head of this paragraph.*

The animal in the extended condition is of an elongated pear-shape, but four-sided instead of circular in section; the smaller end bears the oral aperture, and answers to the manubrium of a medusa, the larger or aboral end answering to the bell. At the middle (that is, half-way between the oral and aboral poles) of each of the four faces is a depression, from which springs a bilobed wing-like appendage, provided with muscles, by the flapping of which the animal is propelled through the water, with the aboral pole forwards. In each division of each wing is an otolithic sac. The mouth leads into an enteric cavity, which is continued into the aboral portion of the hydrosoma. Reproductive organs occur as four masses, probably ectodermal products, in the four longitudinal edges of the body.

The ectoderm consists of large ciliated cells, some of which contain thread-cells, while in others the protoplasm is so modified as to form a gland, presenting a distinct aperture, and a radiating arrangement of the glandular contents. The endoderm cells are so extensively vacuolated as to form a mere network of plasma-threads. The vacuoles probably contain the albuminoid products of digestion; in some of them small aggregations of crystalline rods are found, probably the final products of urinary metabolism. Amongst these vacuolated cells smaller granular endoderm cells occur at intervals, two or three together.

Between the ectoderm and endoderm is a structureless connective

* 'Archiv f. Mikr. Anat.,' vol. xv. (1878) p. 349.

lamella or supporting layer (Stützlamella); it is very thick in the wings, and serves for the attachment of the muscles.

The author concludes with a discussion of the affinities of *Tetrapteron*, which he considers to hold an intermediate place between Polypes and Medusæ.

The Algæ of the White Sea.—This paper, by Dr. C. Gobi, in the Memoirs of the St. Petersburg Academy,* is the first detailed account of the algæ of the White Sea. The species are principally those found throughout the Arctic Ocean; but Dr. Gobi remarks that the vegetation of the southern part of the White Sea has a more northern character than that of the northern part, which is explained by the statement that many forms of Western Europe which make their way to the northern part do not extend to the southern part. Dr. Gobi unites a considerable number of species considered by Agardh and others to be distinct, even regarding *Rhodomela lycopodioides* as a form of *R. subfusca* and *Polysiphonia arctica* as a variety of *P. variegata*. *Rhodophyllis veprecula*, Ag., is referred to *R. dichotoma*, Lepechin. The new species and varieties observed and studied by Dr. Gobi amount to nine, and the total number of species gathered to seventy-six.

The paper contains valuable references to the species of Ruprecht in the Academy's herbarium.

Achromatic Lenses.—Mr. E. M. T. Tydeman, of Liverpool, has obtained provisional protection for an invention which we describe nearly in his own words, as appearing in the printed specification:—"My invention consists of improvements in the construction of compound achromatic lenses suitable for use in Microscopes and other optical instruments, and is intended more completely to eliminate the large irrationality or want of correspondence between the coloured spaces in the various spectra (secondary spectrum), and to render the lenses more perfectly achromatic. It consists in forming the lenses, not as hitherto by the union of lenses made of different kinds or species of glass or other refractive media, but of one kind or species only, yet of different densities and refractive powers, in which the irrationality or unequal refraction of the coloured rays is not so great. I therefore construct my improved achromatic lenses with two or more glasses made from material of the same kind or species of glass (such as that known as flint glass, which is capable of being made of varying density), but of different densities or refractive indices; and I also use flint glass lenses in lieu of the usual crown or plate glass lenses in achromatic object-lenses. For a Microscope object-glass—often composed of two or more approximately achromatic lenses, or set of lenses, either in contact or nearly in contact—I sometimes make one of the several sets of compound lenses of one refracting medium, such as flint glass, and the other set or sets, or single lenses, of a different refracting medium or media, or I use single lenses of crown, or flint, or any other substance in combination, though not necessarily in contact with an

* 'Mem. Imp. Acad. Sc. St. Petersburg,' vol. xxvi. (1878); 'Amer. Jour. Sci. and Arts,' ser. 3, vol. xvii. (1879) p. 71.

achromatic set composed wholly of flint glass or any other suitable refracting substance."

In connection with this subject, we may refer to a paper read by Professor Stokes at the Royal Society,* in which he describes an easy, and at the same time accurate, method of determining the ratio of the dispersions of glasses intended for objectives—a method depending on the achromatizing of one prism by another.

Development of Spongilla fluviatilis.—Professor Ganin, of Warsaw, has undertaken some investigations to decide the following morphological questions:—Does the gastrula stage exist in the developmental history of *Spongilla?* and if it exists, what is its ontogenetic significance? In what way are the germ-layers formed, and in what relation do they stand to the adult structures of the sponge? Does the so-called *syncytium* of Haeckel exist in *Spongilla?* Is the entoderm in sponges confined to the so-called ciliated chambers and their homologues (radial tubes of the Sycones)?

In opposition to Haeckel's views on this last question, it is stated by F. E. Schulze, Barrois, and Metschnikof, that the ciliated chambers (radial tubes) do not open into the digestive cavities, but into cavities or canals which are lined with a continuation of the ectoderm. If this last view of the morphological import of the internal cavities of sponges is correct, the homology of their canal system with the gastro-vascular system of the Cœlenterata disappears, and the place of sponges in the latter group has still to be demonstrated.

The answer to all these questions will be found in the author's forthcoming work, 'Contributions to the Anatomy and Developmental History of Sponges,' of which the following is a brief summary of the more important results.

The ovum of *Spongilla* undergoes a complete segmentation into equal-sized blastomeres, a solid globular mass of cells—the so-called morula—being produced. The peripheral cells of the embryo then begin to multiply more quickly, and thus become distinguished from the larger and darker cells of the inner mass. In this way the two primary germ-membranes, the (primitive) ectoderm and entoderm, are differentiated from each other. Simultaneously with the commencement of this separation, a cavity is hollowed out in the interior of the central mass of entoderm, as the result of the disaggregation and dissolution of its cells. This gastric cavity never opens during the whole period of embryonic development, or during the free existence of the larva. The morula stage passes first into the so-called plano-gastrula or planula stage—a larva of regular oval form, with large internal cavity, and without any external opening. The inner series of the cells of the primitive thick entoderm mass alter their form and structure at an early period, and become the actual entoderm of the adult. The remainder of the entoderm mass forms the mesoderm of the larva. This consists of several rows of dark granular cells, filled with rounded yolk-spheres. The spiculæ of the skeleton begin to develop very early in the interior of the mesoderm cells. The body of the ovoid

* 'Proc. Roy. Soc.,' vol. xxvii. (1878) p. 485.

free-swimming larva thus consists of three different germ-lamellæ. The ectoderm is formed of a series of flagellate cylinder-cells. The mesoderm is a much thicker mass, consisting of rounded amœboid cells. The entoderm is formed of a single row of transparent flat polygonal cells. At the posterior narrow pole of the larva an accumulation of the mesoderm cells takes place at an early period, and occupies nearly a third or a half of the length of the larva. In the anterior clear part of the larva there is found a large gastric cavity. The skeleton is confined to the posterior dark part of the larva. On the external surface of the free-swimming larva are seen a number of ectodermal processes, of different shapes and sizes, which are of no morphological signification. Between the ectoderm and mesoderm of the larva is seen a clear interval, into which the processes of the mesoderm cells project in many places, and which is to be regarded as the body-cavity. The posterior mass of mesoderm grows forwards, as a result of which the stomach-cavity becomes very much narrowed. The larva fixes itself by means of the ectoderm cells of its posterior half, and soon loses its original form and assumes a flat discoid shape. Transverse sections of the body of the larva in such very early stages of the metamorphosis, prove that the at first simple gastric cavity does not disappear, although it is much altered by the great increase of the mesoderm, but passes immediately into the entodermal cavity of the adult *Spongilla*. Very soon after the larva becomes fixed, a number of the so-called ciliated chambers make their appearance simultaneously at several points in the mesoderm; their development depends upon out-pushings of the entoderm. The histological differentiation of these ciliated chambers, which at first are covered with flat cells, takes place somewhat later, after the first central opening of the young *Spongilla* has been formed. This first opening, which must be regarded as the oral aperture, is not formed by invagination of the ectoderm (Barrois), but by a breaking through of the mesoderm and entoderm cells on the upper walls of the stomach-cavity. The oral orifice of *Spongilla* differs from that of other animals in that it does not open externally directly, but into a special cavity, which is to be considered as the body-cavity. The ectoderm and entoderm are always separate in *Spongilla*; the margins of the oral aperture do not become fused with the ectoderm. Soon after the formation of the oral orifice, some of the so-called "ingestive apertures" make their appearance. In the matter of development, structure, and relation to other parts, these structures are perfectly homologous with the oral aperture.

The further development of the young *Spongilla* depends upon the increase of the histological elements of the three membranes, in such a way that each membrane gives rise only to elements of the same morphological significance. The formation of the ciliated chambers by division or by budding of old already-formed chambers, I have never seen. The so-called osculum is homologous, as its development shows, to the porus dermalis. It consists of two layers only (mesoderm and ectoderm). The full-grown *Spongilla* is formed of three different membranes, which originate directly from those of the same

name in the larva. From the ectoderm of the larva is formed the external layer of the skin, which in *Spongilla* consists of two distinct layers, the epidermis and cutis. The larval entoderm forms the thin single-layered lining of all internal cavities or canals (the body-cavity excepted), as well as a covering to the mesodermal septæ, trabeculæ, &c. The mesoderm of *Spongilla* may be regarded as a simple form of connective tissue in which the cell element prevails, and the structureless gelatinous matrix is very slightly developed. A syncytium, in Haeckel's sense, does not exist in the *Spongilla*. Fusion of *Spongillæ* of different forms and sizes never gives rise to the formation of the so called pseudo-oral orifices, pseudo-enteric cavities, communicating canals, and other cavities coated with ectoderm.

We can distinguish in sponges two different modes of development. One group of sponges show in their developmental history a well-pronounced blastula stage, i. e. a hollow single-layered sac with a large segmentation cavity in the interior. Some of those sponges, as *Halisarca lobularis*, *Dujardinii*, *Ascetta primordialis*, *A. clathrus*, have an archiblastula stage; in others of the same group (*Sycandra raphanus*, *compressa*, the calcareous sponges of Barrois), the modified *amphiblastula* form obtained. In this form of the generation cycle the two primitive embryonic membranes originate by the cells of the posterior half of the sac undergoing differentiation into the primitive entoderm, whilst the cells of the other half of the blastula give rise to the ectoderm of the larva. The formation of the gastric cavity in this case depends, in all probability (as F. E. Schultze and Barrois have already noticed), upon the invagination of the posteriorly-situated entoderm, in the interior of the segmentation cavity of the embryo. But whether the aperture of invagination of this provisional archigastrula passes directly into the actual oral orifice of the sponge, remains to be proved. The sponges of the second group begin their ontogeny with the morula stage (all siliceous sponges—*Spongilla*, *Esperia*, *Reniera*, *Amorphian*, *Desmocidon*, *Isodictia*, *Raspailia*; also the calcareous sponges of Haeckel). The formation of all three embryonal membranes depends in this case on the delamination process. The stomach cavity of the larva is formed by the separation and dissolution of some cells of the interior of the entoderm mass. In place of the gastrula, the plano-gastrula makes its appearance. The generation cycle with the blastula stage is to be regarded as the most simple. To this corresponds also the much simpler organization of the sponges of this group: *Halisarca*, for example, has no skeleton, is everywhere covered with the ectoderm of the larva, &c. The sponges which in their developmental history pass through the morula stage, are also more complicated in morphological and histological respects. The place of the sponges as a particular class of the Cœlenterata is entirely natural, on the ground of all the facts hitherto known of comparative anatomy and embryology.*

Mr. F. M. Balfour refers shortly to the above in the article next mentioned, and considers that M. Ganin's account of the development of *Spongilla* is not reconcilable with that of *Sycandra*, as described

* 'Zoologischer Anzeiger,' vol. i. (1878) p. 195.

by Professor Schulze, and that, "considering the difficulties of observation, it appears better to assume for this and some other descriptions that the observations are in error rather than that there is a fundamental want of uniformity in development amongst the Spongida." It would be superfluous for us to lay stress on the value of Mr. Balfour's opinion on such a matter as this.

Morphology and Systematic Position of the Spongida.—In an article in the 'Quarterly Journal of Microscopical Science,'* Mr. Balfour points out that Schultze's last memoir † on the development of Calcareous Sponges confirms and enlarges Metschnikoff's earlier observations, ‡ and gives us at last a fairly complete history of the development of one form of calcareous sponge; and the facts thus established have suggested to him a view of the morphology and systematic position of the Spongida somewhat different to that now usually entertained, though it does not claim to be more than a mere suggestion, which, if it serves no other function, may perhaps be of use in stimulating research.

After a brief statement of the facts which may be considered as established with reference to the development of *Sycandra raphanus*, the form which was studied by both Metschnikoff and Schulze, Mr. Balfour says that he thinks that the larva represents an ancestral type of the Spongida, consisting of a colony of Protozoa, one-half differentiated into nutritive, and the other into locomotor and respiratory forms, thus constituting a link between the Protozoa and Metazoa. He accounts for the ciliated cells becoming invaginated to form part of the lining of the gastrula cavity, by supposing that on the ancestral sponge becoming fixed the locomotive ciliated cells increased in size and number less than the nutritive, and so came to line the cavity of the gastrula, some of the nutritive subsequently passing in at its mouth. In the adult sponge he thinks the descendants of the latter cells which line part of the canals to be alone digestive, the collared cells, the descendants of the ciliated cells, of the larva being mainly respiratory.

Sponge-spicules.—In concluding an article on *Plectronella papillosa*, a new genus and species of Echinonematous sponge,§ Mr. W. J. Sollas says that regarding the various kinds of sponge-spicules as resulting from a variously modified cell-growth, the relations subsisting between the chief of them may be embodied in a diagram.

1. An elongate growth of the original cell in two opposite directions at equal rates gives us the ordinary acerate spicule (Fig. 1), which is biradiate (diactinellid) but uniaxial.

2. A retardation of growth in one radius gives the acuate spicule of Fig. 2.

3. A linear growth in one direction only gives the acuate (Fig. 3);

* N. S., vol. xix. (1879) p. 103.

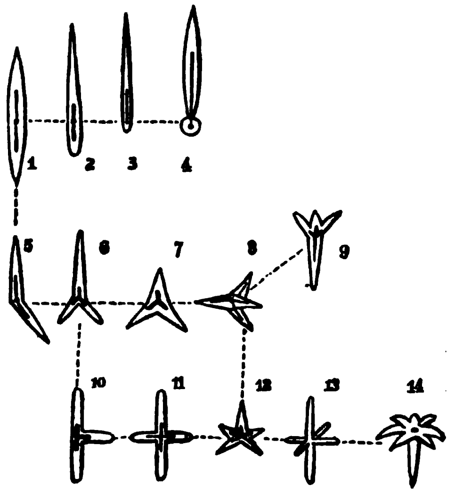
† "Untersuchungen über d. Bau u. d. Entwickelung der Spongien," 'Zeitschr. f. wiss. Zool.,' vol. xxxi. (1878).

‡ Ibid., vol. xxiv. (1874).

§ 'Ann. and Mag. Nat. Hist.,' ser. 5, vol. iii. (1879) p. 23.

if accompanied by increased concentric growth of the initial cell, then the pin-headed acuate (Fig. 4) is produced.

4. An elongation of the cell in two directions, inclined to each other at a less angle than 180°, gives us the curved acerate (Fig. 5), which is both biradiate and biaxial.



5. The inclination of the two rays in Fig. 5 is followed by the appearance of a third in Fig. 6, where we have the triradiate spicule of *Plectronella*. In this spicule two of the radii arise from the proximal face of the cell and grow inwards towards the axis of the fibre on which it is situated, and the third ray arises distally and grows outwards away from the axis.

6. A growth of the cell in three directions making equal angles with each other, and having no determinate relations to any symmetrical line within the sponge, gives us the equiangular triradiate spicule (Fig. 7), which occurs abnormally in *Dercitus Bucklandi*.

7. A quadriradiate growth of the cell in directions having no determinate relations to the form of the sponge gives us the normal spicule of *Dercitus Bucklandi* (Fig. 8).

8. The cell gives off three buds from its distal face, which grow outwards away from the sponge, and a fourth from its proximal face, which grows inwards, and we have the forked forms of *Geodia* and the like (Fig. 9).

9. The cell grows in five directions along three axes at right angles to each other, which are not determinately related to any lines of reference within the sponge (*Dercitus Bucklandi*), or which are so related (*Euplectella* and other Hexactinellids), and we have the quinqueradiate form (Fig. 12).

10. In Fig. 6 the growth of the three rays is along directions inclined somewhere about 120° with each other; if two of the rays grow in opposite directions, and the third at right angles to them,

Fig. 10 results (a form abnormal in *Plectronella*, frequent among the Hexactinellidæ).

Fig. 11 requires no comment.

Fig. 13 is the result of a sexradiate growth of the cell along three axes at right angles to each other, and represents the typical Hexactinellid spicule.

Fig. 14 is an octoradiate form, seven buds having grown out radiately in one plane and the eighth at right angles to them; it occurs in the fossil *Hyalostelia*.

The foregoing remarks arose out of the description of *Plectronella papillosa*, which was the main object of the paper; but the variability of sponge-spicules, Mr. Sollas points out, is far too important a subject to be treated thus incidentally, and might furnish material enough for a lengthy memoir. No sponge that has come under his observation has failed to exhibit numbers of spicules departing more or less widely from the average type; frequently the range of variability is extreme; and no doubt, when a large number of specimens of allied species of sponges come to be carefully compared, we shall find not only in their external form, but in the details of their internal structure as well, easy passages from one to the other, and links will be discovered uniting together types of sponge-structure that now appear widely separated from one another.

Gloidium, a new genus of Protista.—This genus, recently discovered by Dr. N. Sorokin, of Kasan,* differs in many respects from any of the hitherto known forms of Protista. It is a minute myxopod (·03 mm. in diameter), with short, blunt pseudopodia, and protoplasm distinctly differentiated into a clear transparent ectosarc, and a frothy-looking endosarc containing reddish or yellowish granules. There is no nucleus, but a large contractile vesicle in the ectosarc, contracting about every three or four minutes.

Multiplication takes place by division, the process being a somewhat singular one. Constrictions appear in the protoplasm at the opposite poles, and soon after two similar constrictions, the plane of the second division being at right angles to that of the first. Then the pairs of constrictions deepen, extending nearer and nearer to the centre, until, at last, four masses are produced, united to one another by as many delicate threads of protoplasm proceeding from a common point: finally, the four masses become free. At first there is a single contractile vesicle in the centre of the dividing mass, but as division goes on, each mass is provided with a pulsating organ.

The author failed to see any food particles in the endosarc, and supposes that the organism is nourished entirely by imbibition. It is, therefore, devoid of one of the most constant animal characteristics —the power of ingesting solid nutriment.

Under certain circumstances not well understood, encystation takes place. A thin, scarcely noticeable investment is formed by the hardening of the superficial layer of ectosarc. Fresh layers are found in the same way, until a laminated cyst is produced. At one spot all

* 'Morphologisches Jahrbuch,' vol. iv. (1878).

the layers but the outermost one are undeveloped, so that a funnel-like canal is produced, separated from the exterior only by the thin outer layer of the cyst; into this canal—the "germinal pore" (Keimporus)—the protoplasm extends, and after a time escapes through it, by the rupture of its thin outer covering. The process of encystation takes one and a half to two hours; the organism remains encysted from two to three days. After escaping from its cyst, it is slightly smaller than before. No union of different individuals into a plasmodium was observed, so that the life-history of *Gloidium*, as at present made out, is an extremely simple one, presenting merely an alternation of the free and encysted condition.

Preparation of Microscopic Aquatic Animals.—An anonymous writer in the Berlin 'Zeitschrift für Mikroskopie'* gives an account of a process which he has made use of for preparing slides of Infusoria, Rhizopods, Daphnia, Cyclops, Algæ, &c. The only successful attempt in modern times to supply the want of such a process is that of Duncker, of Bernau,† but this, for trade reasons, is kept secret. The author's process, which he thinks may be identical with Duncker's, is as follows:—

By means of a pipette, some drops of the liquid, containing the organisms to be mounted, are introduced into a lac cell not quite hard, and covered with the covering glass. Then some drops of rectified pyroligneous acid (acetum pyrolignosum rectificatum) are placed at the edge of the covering glass so as to be drawn into the cell. This liquid immediately kills all the organisms without altering their form. It only remains to cement the cover down in the usual way. When the pyroligneous acid has become turbid, it must be filtered before being used.

With this method may be combined the staining of the objects by anilin colours. Dissolve one part (in weight) of a solution of anilin colour (the best are anilin blue or diamond fuchsin) in 200 parts of distilled water; after filtering, add 800 parts of pyroligneous acid. Then with this liquid proceed as with the pure acid. After some hours, the objects take a very uniform colour; they are then mounted as above, after adding a little more pure acid. If the colour is too dark, it can be made lighter with acid. The author thinks that his process is capable of improvement, although he has already obtained excellent results from it, and he lays stress upon the facility with which it can be used in travelling.

The Postal Microscopical Society.—This Society was first established in 1873, as the "Postal Micro-Cabinet Club," for the purpose of affording a ready means of communication between microscopists living not only at a distance from each other, but also from London and the other large towns having Microscopical Societies.

The Society is divided into circuits of twelve members each, whose names are arranged geographically. A box of slides is sent by the secretary (Mr. Alfred Allen, of Bath), at fortnightly intervals,

* 'Zeitschrift für Mikroskopie,' vol. i. (1878) p. 273.
† This Journal, vol. i. p. 221.

to the member whose name stands first on the list, who should keep it three evenings only, and then send it to the next name, and he to the following one, the last on the list returning it to the secretary, by whom it is sent to the next circuit, and so on. Each box is accompanied by one or more MS. books, in which the members are requested to make remarks on the slides.

From the Fifth Annual Report it appears that the Society numbers 140, including six ladies who are now eligible for membership. In the Address of the President, Mr. Tuffen West, F.Z.S., F.R.M.S., the safe transit of slides and the best form of postal box were among the principal topics dealt with.

A special feature is the requirement of the Society that each member on admission shall send his carte de visite to the secretary. They are then grouped (sixty or seventy together) and reproduced in permanent photography by the Woodbury process, and supplied to the members.

It is intended to circulate a separate series of histological and pathological slides amongst the medical members.

Life-History of the Diatomaceæ.—M. Paul Petit, whose observations on the revivification of diatoms will be remembered,* contributes to the French Botanical Society some further remarks † on diatoms. That so little is known of their life-history is, he thinks, the fault of the "diatomophiles," who have preferred to create new species or to count the number of striæ on the valves rather than to devote themselves to physiological researches. The impossibility (as M. Petit considers) of growing diatoms in an aquarium, as can be done with others of the lower cryptogamia, necessitates the noting of all the phenomena which are met with in nature. We shall thus, sooner or later, understand the ensemble of the phases through which diatoms pass during their existence.

He accordingly describes the following observations made by Professor Brun, of Geneva:—

On the 5th–7th of January, 1878, M. Brun gathered some mud which covered the rocks at the lower part of the Mer de Glace at Chamounix (1150 metres). Deep snow covered the valley and the mountains, the thermometer standing at 18° (C.) below zero; but as the ice melts in contact with the rock (even in winter), the rock is thus moistened by water at zero. The mud contained a great quantity of diatoms and some desmids, all in a perfect state of vegetation. Lower down in the valley a small piece of water at 0°, covered with ice, was overrun with *Melosira varians* in full vegetation.

Some specimens from the mud of the Mer de Glace were sent to M. Petit by post, and he found that the endochrome of all was in a perfect state, and that the *Naviculæ* exhibited their movement.

The second observation was made in the Valais, on the Bella Tola, at 2600 metres, on the 19th and 20th January. The temperature was 9° below zero, and the snow was lying thick. Here also M. Brun found that the algæ and diatoms were living wherever the snow melted in contact with the warmer rock, and where the light reached.

* This Journal, vol. i. p. 26. † 'Brébissonia,' vol. i. (1878) p. 81.

The specimens sent to M. Petit contained *Melosira arenaria* nearly pure, containing only a few frustules of *Surirella spiralis* and *Epithemia helvetica.* It was easily seen at the first examination under the Microscope that they were in full vital activity.

Thus, according to these observations, diatoms continue to live, and even to develop, in water at 0° with a surrounding temperature of 9° to 18° below zero, provided always that they receive some rays of light.

M. Petit further says that "it is extremely curious to find at these great altitudes species which are found in the plains; it is impossible to distinguish any difference between the Alpine species and the others."

Movements of Diatoms and Oscillatorieæ.—The comparatively rapid movements in the water of diatoms and of certain desmids, and the wavy motion of the Oscillatorieæ, are among the most familiar phenomena to microscopic observers; but their cause is at present involved in much obscurity.

Professor Engelmann, of Utrecht, who has undertaken extensive observations on the subject, thus sums up our present knowledge.* The most probable explanation at present offered, he considers to be that of Max Schultze,† who attributes them to the movements of contractile protoplasm which covers the outer surface of the solid cell-walls; a hypothesis which is confirmed by the following considerations:—Diatoms exhibit this power of motion only when in contact with a solid substratum; they never swim freely through the water; which contradicts the hypothesis that the motion is due to vibratile cilia or to osmotic currents. The phenomenon is especially marked when they lie upon one of their so-called "sutures," and the motion is always in the direction of this suture, either forwards or backwards. Foreign bodies, such as grains of indigo or other pigments, easily become attached to the surface when in contact with a suture, and are moved up and down along it. This motion of the foreign particles takes place only when they lie upon one of the sutures, and then whether the diatom itself is in motion or at rest.

In the case of Oscillatorieæ, the following observations have been made by Siebold:‡—If the water in which these bodies grow is coloured by indigo, the particles of this pigment which come into contact with the separate *Oscillaria*-filaments collect into a rather narrow spiral running round the filament to its apex, whether the filament is in motion or not. Sometimes these creeping spiral lines of pigment begin to be formed at both ends of the filament, and meet in the middle, where the particles become heaped up into little balls; or sometimes they begin in the middle and advance to both ends of the filament. The mode in which the particles of indigo adhere to the alga and to one another appears in this case also to indicate an excretion of mucilaginous protoplasm by the former. Cohn § subse-

* 'Botanische Zeitung,' vol. xxxvii. (1879) p. 49.

† 'Archiv für Mikr. Anat.,' (1865) pp. 376–402.

‡ 'Zeitsch. für wiss. Zoologie,' vol. i. (1849) p. 284 *et seq.*

§ Cohn, in 'Archiv für Mikroskopische Anatomie,' vol. iii. (1867) p. 48.

quently noted the same peculiarity with regard to Oscillatorieæ that had previously been observed in the case of diatoms:—that their oscillating movements take place only when they are in contact with a solid substratum.

This explanation has up to the present time been a hypothetical one; but the external secretion of protoplasm, which Schultze, Siebold, and Cohn had been unable to discover, has at length been detected by Engelmann in the case of a large oscillatoria, *Oscillaria dubia*, Kütz. The method by which he at length succeeded was by passing induction currents through the water in which the alga was growing; when after a few seconds, an excessively thin coating, to which the foreign particles were here and there attached, lifted itself from the surface of the alga, but never to a greater distance than about 0·008 mm. The same took place after the careful addition of dilute potash, the protoplasm subsequently entirely disappearing, which it did also gradually on addition of dilute hydrochloric acid and 10 per cent. solution of sodium chloride. With eosin and picro-carmine the thin layer became distinctly coloured. The protoplasmic layer was also subsequently made visible by the sudden addition of strong nitric acid. It is probable that the immobile thread-like cilia, coloured yellow by iodine, which had been detected in some Oscillatorieæ, as *Oscillaria viridis* and *Phormidium vulgare*,* may be portions of the same external protoplasm.

The Use and Abuse of Diatoms as Test Objects.—The following remarks are not strictly new, but at the same time we do not remember having previously seen the matter so well put. They occur in a paper by Mr. G. D. Hirst, the secretary of the Section of Microscopical Science of the Royal Society of New South Wales ("Notes on some Local Species of Diatomaceæ"), in the volume recently issued of that Society's 'Journal and Proceedings':†—

In conclusion, I would say a word in reply to questions I have heard put sometimes, when, after the expenditure of much time, trouble, and patience, adjusting of light and mirror, the lines on some difficult test diatom have at last been fairly displayed: "Well, what good have you accomplished? In what respect is microscopic science benefited by the fact that such a diatom has so many lines to the inch?" There are, I know, many microscopists who affect to despise those whom they call "Diatomaniacs," and count the time and trouble expended in the resolution of markings as simply wasted. Now, without for a moment arguing that the only or chief work for the Microscope is counting the striæ on diatoms, I would hold that the time spent in successfully resolving a difficult test is by no means wasted. The tyro, sitting down before his newly acquired instrument, places an object on the stage, turns on the full glare of light from his mirror and condenser, and fancies he sees everything to perfection. Let him try the same method of proceeding on some delicate diatom-valve; and where in the hand of the skilful manipulator a moment

* Nageli, in 'Beiträge zur wissenschaftlichen Botanik,' vol. ii. (1860) p. 91.

† 'Journal and Proceedings of the Royal Society of N. S. Wales,' vol. xi p. 272.

before, lines or beading were beautifully displayed, he sees a blank. He may spend long hours in trying every trick of illumination, moderating his light, varying its obliquity by altering the angle of his mirror, focussing and re-focussing the condenser, altering the adjustment of his objective; and at last, when his patience is well-nigh exhausted, the desired result is obtained, the delicate markings start suddenly into view, and he possesses the consciousness that, under his hands, mirror, condenser, and objective are now doing their best. Has this time been wasted? I think not. He will carry the knowledge obtained in the struggle, and apply it in the broad field of real work that lies before him on every side. Should he turn his attention to the development of minute life, organs are seen in living transparent bodies where before he saw nothing; should he be a pathologist, tissues appear full of structure which before in his inexperienced hands seemed homogeneous, minute nerve-fibres become visible where before they were unsuspected. I do not think I am exaggerating in saying what I have; I have felt the benefit conveyed in an education of this kind, and I could recommend nothing better for a beginner than a year's constant study of all the species of *Diatomaceæ* at his command. When he is fully convinced that he sees all in them that his optical means will allow, he is far better fitted to commence real work than he ever could have been without this preliminary training. Only, let us not mistake; our work, though commencing on diatoms, should not end there; let their delicate lines be the means of familiarizing ourselves with the optical capabilities of the noble instruments at our disposal, and the questions I have quoted will be duly answered —the time spent will not be in vain.

To the same effect are some remarks made by Mr. J. Mayall, jun., in an address on "Immersion Illuminators," recently delivered before the Brighton and Sussex Natural History Society:—"Practice with diatoms should be regarded as the gymnastics of the Microscope. To ignore this practice is voluntarily to paralyze our possible skill, which cannot be done with impunity, as is proved by the immense mass of old results that are constantly being discarded to make way for interpretations based on more perfect instrumental and manipulative means. The improvements in the Microscope are almost wholly due to the criticisms of amateurs skilled in the exhibition of test objects."

Measurement of the Amplification of Optical Instruments.—The following was communicated by M. Govi to the French Academy, and, being printed in their 'Proceedings,'* we have thought that a translation might properly find a place here. Those who may not altogether agree with the views expressed, may still find some interest in the fact of the paper having been accepted by the Academy:—

By amplification is meant the relationship of size between the image and the object. The idea of size, obtained by looking at an image, without actually measuring it, is not in any way precise.

If optical instruments only gave *real* images, their magnifying

* 'Comptes Rendus,' vol. lxxxvii. (1878) p. 726.

power would be very easily determined, and there could be no dispute as to it. *Virtual* images have, nevertheless, quite as measurable a size as real images, and have, like the latter, a determinate place in space.

We must not, then, gratuitously suppose that the eye constantly refers them *to the distance of distinct vision*, because, first of all, such a distance does not exist for normal eyes, and that, if even it did exist, it would not be of any use for the measurement of the amplification; since each observer, and the same observer every time that he refocusses an image, places it, or may place it, at a different distance.

It is sufficient, to prove this, to make several people focus an image, and examine its distance every time, by means of a *megameter*,* a little astronomical telescope with graduated draw-tube and micrometer eye-piece. It is thus found that nearly all the focussings give different distances.

The megameter enables us, besides, to measure, in every case, the actual size of the image, by referring it, by the micrometer eye-piece, to a divided scale, looked at directly through the megameter, of which the focus has not been changed. The image once measured, it only remains to divide it by the size of the object in order to have the amplification.

The *camera lucida* and the process of *double vision* ("*double vue*") also give the means of measuring the amplification, because the eye is a pretty good judge of the distance of images, and consequently of their size, when it can compare them to different objects whose place is exactly determined (pencil, paper, divided scale, &c.). In having recourse to these processes of measurement, we recognize that instruments with *virtual* images give all the amplifications possible, from a minimum up to infinity, each corresponding to a different distance of the image.

It is therefore inexact to say that such and such a lens, or Microscope, magnifies the image of objects a certain number of times, unless we add at what distance such an image ought to be for the indicated amplification to be realized.

The magnifying power of different instruments could be exactly defined, by measuring for each of them the amplification produced at a fixed distance—a decimetre, for example—because all other amplifications could be deduced from that, with sufficient exactitude, by a simple proportion.

What has led to the supposition that virtual images (in the Microscope especially) were constantly referred to the same distance (the distance of distinct vision), is probably the fact that, in spite of the enormous variation of distance and size, which virtual images, given by optical instruments, undergo, they always subtend in the eye nearly the same angle,† do not vary sensibly in brilliancy, neither lose nor

* See, on the measurement of magnifying powers and the use of the megameter, 'Monitore toscano,' 20 August, 1861; 'Memorie della R. Accademia dello Scienze di Torino,' vol. xxiii. pp. 455–465; 'Nuovo Cimento,' vol. xvii. p. 177.

† The method employed by astronomers to measure the amplification, gives accurate results, in consequence of the almost absolute invariability of the angle subtended by the image.

gain in any of their details, and seem consequently not to move in space. In Microscopes of high magnifying power, the tenuity of the pencils of rays which start from every point of the image also contributes to make its position in space uncertain to the eye, since the accommodation is no longer necessary in order to see it tolerably clearly. However, it none the less exists in a definite place in space, where we must go to measure it in order to know the true amplification; and here again the *megameter* can be employed with advantage.

Discosporangium, a new genus of Phæosporeæ.—The fact that the majority of Phæosporeæ are only to be met with during a portion of the year, led M. Falkenberg (at the Naples Zoological Station) * to the conjecture that they may at certain periods withdraw themselves to great sea-depths. Although this conjecture was not confirmed, it led to the discovery of a new genus at a depth of 15 metres, off Cape Misenum. This sea-weed, to which Falkenberg gives the name *Discosporangium subtile*, consists of filaments of cells growing by an apical cell. They have lateral branches, springing from the middle of the cells of the filament. The origin of the sporangia (zoosporangia) is the same. They are placed solitary at the centre of the cells, and form a unilamellar square plate, the compartments of which open, when ripe, on the upper side of the sporangium. The further development of the zoospores was not observed. The author suggests that the zoospores produced in unilocular and plurilocular sporangia of the Phæosporeæ perform different functions. Although the systematic position of *Discosporangium* is still doubtful, Falkenberg considers its nearest ally to be *Choristocarpus*, a genus separated from the Ectocarpeæ by the mode of development of the thallus. In the course of his researches the author had the opportunity of confirming the observations of Sirodot on the genetic connection of *Chantransia* and *Batrachospermum*. He also gives a list of a considerable number of species of marine Florideæ which bear on the same individual both tetraspores and capsular fruits, as, for instance, species of *Callithamnion* and *Polysiphonia*.

Reproduction of Ulvaceæ.—The reproduction of three species, *Monostroma bullosum*, *Tetraspora lubrica*, and *Ulva rigida* has been studied by J. Reinke.† In the first-named species he observed the formation and conjugation of the zoospores, the development of the resulting zygospore into a resting spore, and the subsequent conversion of the latter, by division of its contents, into a young *Monostroma* thallus. The non-sexual reproduction of the plant was also observed.

The observations on *Ulva rigida* showed that in this species also new individuals are produced from resting spores without the intermediate formation of zoospores.

In *Tetraspora lubrica* the macrozoospores, after a short free existence, settle down and divide into four, the daughter-cells being either all in one plane, or arranged tetrahedrally. Multiplication

* 'Mittheilungen der Zoologischen Station zu Neapel,' vol. i. (1878) p. 54.
† 'Jahrb. f. wiss. Bot.,' vol. xi. (1878) p. 531.

of these cells begins and continues, in the first case, in one plane, in the second radially. Usually several macrospores come to rest together, and then the young thalli formed from them fuse together into a single irregular mass. The formation of microzoospores was also observed, and their conjugation; the resulting zygospore grew to the size of a macrospore, and then divided in the same way as the latter.

Nostoc-colonies in Anthocerotese.—The colonies of parasitic *Nostoc* occurring in the thallus of various species of *Anthoceroteæ* were investigated some years since by Janczewski, and have now been studied again by Leitgeb.* He finds that the motile filaments of the parasites penetrate through the young stomata, the air-cavities in connection with them being then filled with mucilage. Sometimes, however, infection seems to be brought about by a few isolated *Nostoc*-cells, or even by a single cell. It is probable that there is more than one species of *Nostoc* inhabiting the different genera of Anthoceroteæ, but this is not certain.

For further details we must refer our readers to the paper itself. It is illustrated by one plate, showing the formation of the stomata and air-cavities, and the relation of the *Nostoc*-colonies to them.

Support for the Head in Drawing with the Camera Lucida.—A writer in 'Science-Gossip'† points out the assistance which the draughtsman will receive by keeping the *head* steady as well as the hand, and explains a device he has made use of for this purpose. It consists simply of two upright brass rods with a flat sliding cross-bar (covered with some soft substance) between them, which can be screwed tight at any height, and on which the forehead is placed in the position desired.

Alcoholic Fermentation.—The 'Comptes Rendus' have continued to contain further "observations" and "replies" on the discussion raised between M. Pasteur and M. Berthelot in regard to the posthumous MSS. of the late Claude Bernard. We noticed at p. 270 of vol. i. the commencement of the controversy, and at p. 82 of this volume M. Pasteur's refutation of M. Bernard's views. This was criticised by M. Berthelot,‡ who maintained his original view, that the action of ferments is reducible to purely chemical conditions independent of life; to whom M. Pasteur again replied, § charging M. Berthelot with putting forward entirely gratuitous hypotheses which have never been supported by any personal observations. He thus describes the hypotheses:—1st. In alcoholic fermentation there is perhaps produced a soluble alcoholic ferment. 2nd. This soluble ferment perhaps consumes itself in proportion to its production. 3rd. There are perhaps conditions in which this hypothetical ferment would be produced in greater proportion than the amount destroyed. M. Pasteur deals seriatim with M. Berthelot's objections, and says that if he will endeavour to support his hypotheses by experiments,

* 'Sitzungsb. k. Wiener Akad. du Wiss.,' vol. lxxvii. (1878) p. 411.
† 'Hardwicke's Science-Gossip,' No. 170 (1879) p. 32.
‡ 'Comptes Rendus,' vol. lxxxvii. (1878) p. 949.
§ Ibid., p. 1053.

and should discover a soluble alcoholic ferment, he (M. Pasteur) would applaud his discovery, which would be very interesting, and not in any way annoying. If he should arrive at conclusions contrary to the principles established by M. Pasteur, the latter assures him that "he would hasten to do for those conclusions what he has done for Bernard's, viz. demonstrate their fallacies," and he calls upon M. Berthelot to controvert his statements, not by *a priori* theories, but by serious facts.

On this reply M. Trécul made some observations* tending to charge M. Pasteur with holding contradictory opinions in stating that he adhered to his original classification of microbia into aerobic or azymic, and anaerobic or zymic, while at the same time founding a third class, which, according to circumstances, have the property of living in air or without oxygen. M. Pasteur contented himself with saying that M. Trécul's memory was at fault, and that since 1861 he has always maintained the existence of the three kinds of organisms.

Another "Reply to M. Pasteur" from M. Berthelot was read on the 6th January,† in which, after some preliminary remarks, he "comes to the question of the organisms which borrow from the sugar, according to M. Pasteur, combined oxygen in place of the free oxygen with which the air provides them in the ordinary conditions of their existence." He retorts upon M. Pasteur the absence of any support from "serious facts," and asserts that, on the contrary, serious, positive facts prove that the "nutrition of yeast results from a complex ensemble of chemical transformations, an ensemble which it would be dangerous to the progress of science to simplify by the apparent clearness of a pure supposition founded on a physiological antithesis. A sufficient number of valuable discoveries have established the reputation of M. Pasteur, so that he can give up without detriment a theory so little justified by facts."

M. Trécul subsequently laid before the Academy ‡ a detailed paper, in which he endeavoured to establish his assertions by numerous extracts from M. Pasteur's writings. M. Trécul considers :—

1st. That the organized ferments are only particular states of more or less complicated species, which are modified according to the media in which they are.

2nd. That in place of establishing three classes of inferior organisms, as M. Pasteur proposes, there is really only one, each species being able to present one or many aerobian states, and one or many anaerobian states.

The activity of the subsequent controversy may be judged of by a reference to our "Bibliography," where will be found the list of the "Replies," "Second Replies," "Third Replies," "Fourth Replies," "Last Replies," and further "Observations," and "Notes" of MM. Pasteur, Berthelot, and Trécul, with which the subsequent numbers of the 'Comptes Rendus' abound.

The discussion between M. Pasteur and M. Trécul was closed by

* 'Comptes Rendus,' vol. lxxxvii. p. 1058.
† Ibid., vol. lxxxviii. (1879) p. 18.
‡ Ibid., p. 54.

the following "reply" of the former:*—"Ma classification est ce qu'elle est. Acceptez-la ou rejetez-la, cela vous regarde. Pour moi elle est excellente!"

Bacteria in the Poison of Serpents.—M. Lacerda calls the attention of the French Academy to a fact he observed at the physiological laboratory at Rio de Janeiro.

Contrary to the general belief that the venomous matter is nothing but a poisonous saliva acting like *soluble ferments*, he observed facts which prove, in his opinion, that it contains *figured ferments*, whose analogy with bacteria was remarkable. Subjecting a snake to chloroform, he extracted from it a drop of its poison on a glass plate, previously washed in alcohol and slightly warmed. Immediately placing it under the Microscope, a kind of protoplasmic filamentous matter was seen, formed of an aggregation of cells, arranged in an arborescent form like certain Lycopodiaceæ.

Gradually the filament (enlarged where the spores are) is dissolved and disappears, and the spores are set at liberty, assuming a linear arrangement. Then, if the conditions of the surrounding medium are favourable to their development, they swell and enlarge sensibly, pushing out, after a time, a kind of small tube, which quickly lengthens. This soon separates, and forms another spore, which is reproduced in the same way.

When these spores have attained a certain size, a filament is observed in their interior, which becomes more and more marked, and presents here and there ovoid and very refractive corpuscles; in a short time the protoplasm of the spore is retracted, its membrane is dissolved, and the corpuscles are set at liberty to continue afterwards the same process of reproduction.

The spores have, however, two principal modes of multiplication—by scission and by internal nuclei. In the blood of animals killed by the bite, the following phenomena were observed:—

The red globules began by showing small brilliant points on the surface of the disk, which sometimes formed projections and became more and more numerous. By following attentively the different phases of the change, he succeeded in seeing the globule completely destroyed, and replaced by numerous ovoid very brilliant corpuscles, endowed with spontaneous oscillatory movement. Sometimes they were not disengaged from the globular mass, but remained enclosed within it, and the globules became fused with each other, forming a sort of amorphous very diffluent paste.

The animals in which a hypodermic injection was made of the blood, immediately after the death of the animal bitten, all died in a few hours, with almost the same symptoms, and their blood always showed the same changes remarked in animals directly poisoned.

M. Lacerda also ascertained that alcohol injected under the skin, or introduced through the mouth, is the real antidote against this ferment.

In presenting this paper, M. de Quatrefages added that in his

* 'Comptes Rendus,' vol. lxxxvii. p. 255.

opinion it was necessary to make "serious reserves as to the conclusions of the author."

Flagellated Organisms in Rats' Blood.—In the 'Fourteenth Annual Report of the Sanitary Commissioner with the Government of India' is a paper on "the Microscopic Organisms found in the Blood of Man and Animals," by Mr. T. R. Lewis, M.B., in which he disputes the correctness of what he terms one of the fundamental tenets of M. Pasteur's creed, viz. that neither microscopic organisms nor their germs are ever found in the blood of an animal in health.

In July, 1877, he detected organisms in the blood of a rat which he was examining. Under the Microscope, the blood appeared to quiver with life, and on diluting it with a half per cent. solution of salt, motile filaments could be seen rushing through the serum, and tossing the blood-corpuscles about in all directions. Their movements were of a more undulatory character than spirilla, and the filaments were thicker, more of a vibrionic aspect. They were pale translucent beings, without any trace of visible structure or granularity. It was observed that every now and then blood-corpuscles some considerable distance from any visible motile filament would suddenly quiver. On carefully arranging the light, it was seen that this was due to a very long and exceedingly fine (apparently posterior) flagellum. These hæmatozoa may sometimes be kept alive for two or three days, but generally die and disappear from view within twelve or twenty-four hours, as though they had been dissolved in the serum in which they were found. They may be preserved by spreading out a thin layer of the blood containing them over a thin covering glass, and inverting it over a weak solution of osmic acid. The preparation should be removed as soon as it presents a dry, glazed appearance, and may be thus mounted in the dried condition, or in a saturated solution of acetate of potash. The flagellum cannot be detected in such a preparation; apparently the refractive index of the substance forming the flagellum and that of the serum approximates so closely, that it can only be detected when creating a current by its movements.

The body-portion may be measured after they have been killed by means of osmic acid. The width of the anterior half or body-portion averages ·8 to 1 μ, or precisely that of ordinary blood-bacilli, and its length from 20 to 30 μ. The flagellum, so much of it as is visible, is somewhat of the same length, though possibly considerably longer, as the slope from the body-portion is very gradual; and when the eye follows it to the bounds of visibility, an impression is conveyed that there may be still more of it.

On applying electricity to a drop of the blood, it was found that an interrupted current of such a strength as could not be comfortably borne by an individual was tolerated by these beings for several consecutive hours.

The species of rats in which these organisms were found were *Mus decumanus* and *M. rufescens*. They were never found in mice.*

* 'Quart. Journ. Mic. Sci.,' N. S., vol. xix. (1879) p. 109.

Deceptive Appearances produced by Reagents.—A paper recently communicated by Dr. George Thin to the Royal Society * under this title, was intended, in addition to being a contribution to the histology of hyaline cartilage, to illustrate how much the apparent structure of a tissue which is being examined microscopically depends on methods of preparation.

In the examination of a cartilaginous tumour of the lower jaw, the author was able to isolate the cells from the cartilaginous substance of the tumour after the action of osmic acid. All the cells observed were flattened, rounded, or somewhat polygonal bodies, with round nuclei. Their contours did not correspond exactly with those of the rounded cartilage "capsules" in which they lay.

The examination of this tumour showed that most delusive appearances as regards the nature of cartilage cells may be sometimes produced by staining and hardening agents. Carmine and eosin, by staining an unformed substance that exists in the structure in defined tracts, may simulate branched protoplasmic cells, and bichromate and logwood preparations, either in sections or teased out, may as closely simulate cells with fibre processes.

These facts justify, the author considers, serious doubts as to the correctness of interpretation in all cases in which histologists have described branched cells in hyaline cartilage, whether the latter existed as a normal structure or as a pathological growth. They further show that, taken alone, carmine or eosin-staining should not be held as conclusive evidence of the existence or limits of cellular protoplasm in any animal tissue.

Preparation of Red Blood-corpuscles.—Very excellent permanent preparations of the red blood-corpuscles of Amphibia may be made by Ranvier's method, as follows:—Some blood is allowed to drop from a wound into about two hundred times its volume of a saturated picric acid solution. After a few minutes the picric acid is carefully poured off, leaving most of the corpuscles at the bottom of the dish; a solution of picro-carmine is then poured over them, and allowed to stand a day or two. The picro-carmine is then poured off, and the sediment put into acid glycerin (glycerin 100 parts, acetic acid 1 part). The corpuscles so treated will last a long time, and may be mounted in the acid glycerin at any time. The nuclei of the corpuscles are stained bright red, and the body light yellow. Corpuscles of *Menobranchus*, which are about twice as large as those of the frog, prepared in this way nearly a year ago, appear perfect as ever.

Apparatus for Determining the Angle of the Optic Axes of Crystals with the Microscope.—Professor A. de Lasaulx, referring to a previous paper,‡ in which he described a method he had devised for this object, says that it often presents difficulties, as it supposes

* 'Proc. Roy. Soc.,' vol. xxviii. (1878) p. 257.

† Mr. S. H. Gage, in 'Amer. Quart. Mic. Journ.,' vol. i. (1879) p. 160.

‡ 'Bulletin de la Société Belge de Microscopie,' vol. iv. (1878) p. 177, noticed in part in this Journal, vol. i. p. 207 .

that we have two thin plates of the mineral to be examined, cut perpendicularly to one another. In the case of all minerals whose cleavage in one direction is very perfect, it is difficult, and often even impossible, to cut a thin plate normal to the direction of the cleavage. It was, therefore, desirable to be able to determine the apparent angle of the optic axes by direct measurement with the Microscope. In all cases where a mineral only becomes transparent when the plates are very thin, the determination of the angle of the optic axes can only be effected in general with the Microscope.

To arrive at this result, the distance of the poles of the optic axes of a mineral, as seen in the interference image, must be compared with this same distance in a film of biaxial mica, for which the angle of the optic axes has been determined by an instrument specially designed to measure it.

To make a sufficiently exact comparison of the distances of the poles in the film of mica, and in the thin plate of the mineral to be examined, we must be able to measure exactly these two distances in the Microscope. As the eye-piece is removed in order to see the interference image, the eye-piece micrometer cannot be used without employing lenses by which the interference image is distorted.

The following form of apparatus has accordingly been designed by Professor de Lasaulx. On the edge of the setting of the upper Nicol, a brass cover A (Fig. 1) is fixed by screws *d*, having a diaphragm of

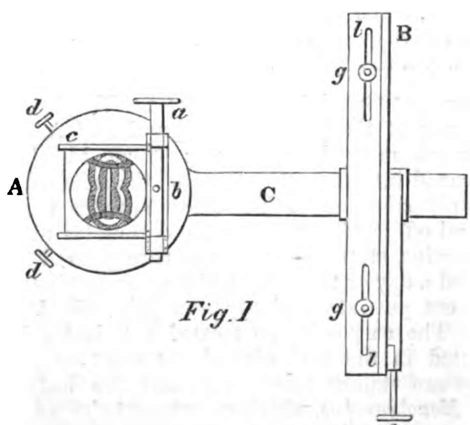


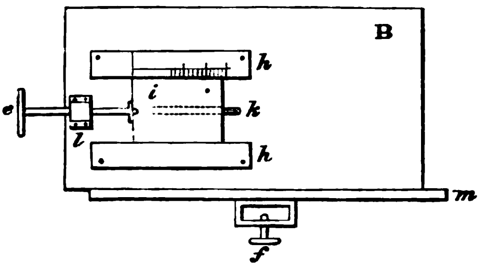
Fig. 1

the same size as the glass which covers the Nicol. At one side there is a horizontal axis which can be turned by the screw *a*, and at the same time this axis and the plate which it supports can be turned round a screw *b*. This axis holds an ordinary covering glass *c*, through which may be seen the image in the Microscope. A rod C carries the other part of the apparatus B, which consists of a blackened rectangular screen with a very fine horizontal slit *k* (Fig. 2) in the middle. On one side the screen has a small slide *i*, which by the screw *e* passing through *l*, may be moved in the grooves *h* to the right or to the left,

and the slit opened or shut. One of the grooves has a graduated scale, by which the length of the open slit is shown.

The apparatus is fixed on the Microscope in such a way that the slit in the screen is illuminated by the light of the window. If the glass *c*

Fig. 2



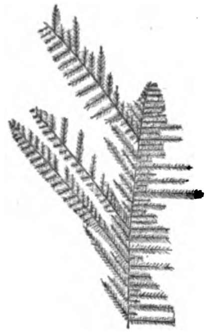
is then raised to an angle of 45° with the horizon, no difficulty will be experienced in seeing a reflected image of the slit *k* on the glass, in the middle of the diaphragm of A. Hence, looking through the glass into the Microscope, we see simultaneously the interference image and the reflected image of the slit, which appears as a brilliant line. It now remains to bring one of the two extremities of the image of the slit over one of the visible poles of the optic axes. That this may be done, the screen B is movable on the plate *m*, which serves as its base, and with which it is fixed by the screw *f* on the rod C; the two screws *g* are inserted in the oblong openings *l*, and by loosening these screws a little the screen can be moved upon the base-plate to the right or to the left, so that the desired position may be obtained. By opening the slit we can make the other end of its image coincide with the pole of the other optic axis in the interference image. This position is represented in Fig. 1.

The scale shows the length of the opening of the slit, and the distance of the poles of the optic axes. Measuring by the same method the distance of the poles for mica, of which the apparent angle of the optic axes is known, the proportion is found of the two distances, which enables us to calculate easily the angle of the optic axes. The scale is carefully graduated in fifths of a millimetre, and with the help of a lens the third of a degree can easily be distinguished, and the error in the results is found not to exceed one or two degrees.

It will be understood that this method is only applicable to minerals in which the angle of the optic axes is not large, or the poles of the axes would be no longer visible. But it is easy to put the preparation in a small cup of oil, and then measure the angle in the oil.

Artificial Crystals of Gold.—A few years ago some objects from America were exhibited which, under a power of 150 to 200, looked like microscopic fern-leaves gilt (see woodcut), but which were stated to be crystals of gold. The process by which they were produced was

not disclosed, and several ineffectual attempts were made to reproduce them. The following is stated to be the method of manufacture:*—



A solution of chloride of gold and ammonium is placed in a shallow dish coated with heavy gold foil, which is connected with the zinc plate of a large Daniell's battery. Near the top of the solution, and connected with the copper plate of the battery, a roll, made up of thin strips of pure gold, is suspended, enclosed in a muslin bag. The strength of the battery current is controlled by a coil of wire arranged as a rheostat, a clamp terminating one of the battery wires enabling the operator to include a greater or less number of coils in the circuit. The necessary conditions being fulfilled, on completing the circuit the gold is gradually dissolved from the roll and deposited on the bottom of the dish in bright crystalline flakes, having the appearance of feathers or fern-leaves when examined under the Microscope.

The Vertical Illuminator.—This illuminator was originally intended to be used in conjunction with medium-power dry objectives, of moderate angles, such as were formerly so much in vogue. Mr. Morehouse, a well-known microscopist of Wayland, New York, has found that by the conjoint use of the illuminator with immersion objectives of high balsam apertures, astonishing results may be secured; as, for instance, the resolution of the markings of Podura and other insect scales, the striation of valves of *Frustulia Saxonica*, *Surirella gemma*, and similar "difficult" diatoms, under amplifications of 3000 and 4000 diameters, and, as a matter of course, by reflected light.

Dr. Edward Smith has devised a modification,† consisting of an adjustable shutter, regulating the admission of light, thus greatly improving the brilliancy of the objects, accompanied with marked increase of resolving power; and with the instrument thus modified he had no difficulty in obtaining beautiful displays of the Nobert 19th band, the simultaneous exhibition of the long and transverse striæ of *Frustulia Saxonica*, &c., under powers of 3000 and 4000 diameters.

Desiring to test it on histological preparations, he thus examined a slide of human blood, improvised for the occasion, and was astonished to find about three-fourths of the red corpuscles nucleated. The amplification employed in these observations was about 3700 diameters.

A point which should not be lost sight of is that the vertical illuminator can only be successfully used in conjunction with an objective of high balsam angle.

* Mr. A. H. Chester, in 'Amer. Journ. of Sci. and Arts,' 3rd ser., vol. xvi. (1878) p. 29.

† 'American Naturalist,' vol. xiii. (1879) p. 137.

Reproduction of Noctiluca.—At p. 331 of vol. i. we quoted from 'Comptes Rendus' a paper by Professor Ch. Robin on this subject. The further detailed memoir there mentioned is published in the author's 'Journal de l'Anatomie et de la Physiologie,'* where, besides the greater completeness of the text (67 pp.), it has the advantage of being accompanied by seven plates.

* 'Ann. and Mag. Nat. Hist.,' ser. 5, vol. xiv. p. 563

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Duval, G.: On the Genesis of Figured Ferments. (8vo. Paris, 1878.)

Edgeworth, M. Pakenham: Pollen. (24 plates.) Second Edition. (8vo. London, 1879.)

Frey, Prof. H.: Outlines of Histology. Second Edition. (213 woodcuts.) (8vo. Leipzig, 1879.)

„ „ : Treatise on Histology and Histo-chemistry. Second French Edition, by Dr. Spillman. (634 woodcuts.) (8vo. Paris, 1878.)

Haeckel, Prof. E.: The Evolution of Man. 2 vols. (11 plates and 162 woodcuts.) (8vo. London, 1879.)

Hager, Dr. H.: The Microscope and its Employment. Sixth Edition. (231 woodcuts.) (8vo. Berlin, 1879.)

Hallier, E.: The Plastids of the Lower Plants. (4 plates.) (8vo. Leipzig, 1878.)

Klein, E., M.D., F.R.S., and E. Noble Smith, L.R.C.P., M.R.C.S.: Atlas of Histology. Part I. (4 plates.) (Roy. 4to. London, 1879.)

McCoy, F.: Natural History of Victoria, or Figures and Descriptions of the Living Species of all classes of the Victorian Indigenous Animals. Decade I. (10 plates.) (Roy. 8vo. London, 1878.)

Möbius, Prof. Dr. C.: The Structure of *Eozoon Canadense*. (18 plates.) (Roy. 4to. Cassel, 1878.)

Muhr, J.: The Oral Parts of Insects, in five wall charts. (Fol. Prague, 1878.)

Rabenhorst, L.: The Algæ of Europe. (Decades 253–5.)

Sars, Prof. Dr. G. O.: Contribution to the Knowledge of the Norwegian Arctic Fauna. I. Mollusca of the Norwegian Arctic Region. (Map and 52 plates.) (8vo. Christiana, 1878.)

Schmidt, Dr. O.: Brehm's Animal Life. Second Edition. Division IV. Invertebrata. Vol. II. The Lower Animals. (16 plates and 366 woodcuts.) (Leipzig, 1878.)

Smith, Hamilton L.: Species Typicæ Diatomacearum. Cent. III. (Geneva, N.Y., 1878.)

Stahl, E.: Contributions to the Development-history of Lichens. Part II. (Leipzig, 1878.)

Stierlin, Dr. R.: Beer; its Adulterations and the means of demonstrating them. Second Edition. (4 plates.) (8vo. Bern, 1878.)

Von Thümen, Felix: Fungi Pomicoli. Monograph of the Fungi occurring on the Fruits of Temperate Climates. (3 plates.) (8vo. Vienna, 1879.)

„ „ : The Fungi of the Vine. Monograph of all the Fungi

hitherto known occurring on the Species of the Genus *Vitis*, Linn. (5 plates.) (8vo. Vienna, 1878.)

Wittrock, V., and O. Nordstedt: Algæ aquæ dulcis exsiccatæ præcipue Scandinavicæ, &c. Fasc. 3 and 4. (Upsaliæ, 1878.)

Ziegler, M.: Struggle for Existence between the Animal Organism and Microscopic Algæ. (8vo. Paris, 1878.)

JOURNALS, TRANSACTIONS, &c.:—

England.

Annals and Magazine of Natural History, Fifth Series, Vol. III., No. 14 (February):—

On some new and rare Hydroid Zoophytes (*Sertulariidæ* and *Thuiariidæ*) from Australia and New Zealand. D'Arcy Thompson. (2 plates.)

On the Bryozoa (Polyzoa) of the Bay of Naples (*continued*). Arthur Wm. Waters, F.G.S. (2 plates.)

On *Loxosoma* and *Triticella*, Genera of Semiparasitic Polyzoa in the British Seas. Rev. A. M. Norman, M.A.

On *Holasterella*, a Fossil Sponge of the Carboniferous Era, and on *Hemiasterella*, a new Genus of recent Sponges. H. J. Carter, F.R.S., &c. (1 plate.)

Remarks on Munier-Chalmas's Classification of the *Dactyloporida*. Dr. Fr. Toula.

On the Classification of the British Polyzoa. Rev. Thomas Hincks, B.A., F.R.S.

Miscellaneous.—On the Genus *Catagma*. W. J. Sollas, M.A., F.G.S., &c.—On the Development of the Chilostomatous Bryozoa. M. J. Barrois. (From 'Comptes Rendus.')—Migration of the Aphides of the Galls of the Pistachio to the Roots of Grasses. M. J. Lichtenstein. (From 'Comptes Rendus.')—Notice of a *Tetrarhynchus*. Prof. Leidy. (From 'Proc. Acad. Nat. Sci. Philad.')

No. 15 (March):—

On an Anomaly among the Hydromedusæ, and on their Mode of Nutrition by means of the Ectoderm. C. Mereschkowsky. (1 plate.)

On the Structure of *Amphibola avellana*. F. W. Hutton, F.G.S., Prof. of Nat. Hist. in the University of Otago, N.Z. (1 plate.)

On a Collection of Lepidoptera from the Island of Johanna. Arthur G. Butler, F.L.S., F.Z.S., &c.

On the Bryozoa (Polyzoa) of the Bay of Naples (*continued*). A. W. Waters, F.G.S. (2 plates.)

Notices of British Fungi (*continued*). Rev. M. J. Berkeley, M.A., F.L.S., and C. E. Broome, F.L.S.

Descriptions of four new Species of the Genus *Inopeplus* (Coleoptera, Cucujidæ). Charles O. Waterhouse.

Notes on the Lepidoptera of St. Helena, with descriptions of new Species. Mrs. T. Vernon Wollaston.

Bibliographical Notices:—Journal of the R. M. S., Vol. II., No. 1.

Miscellaneous.—Method of Investigating the Embryos of Fishes. M. F. Henneguy. (From 'Bull. Soc. Philom.,' Paris.)—On a Gigantic Isopod from the great depths of the Sea. M. A. Milne-Edwards. (From 'Comptes Rendus.')—On the Termination of the Visceral Arterioles of *Arion rufus*. M. S. Jourdain. (From 'Comptes Rendus.')—The Eye in the Cephalopoda. Prof. S. Richiardi. (From 'Soc. Toscana di Sci. Nat.')

Grevillea, Vol. VII., No. 43 (March):—

British Sphæriacei. M. C. Cooke and C. B. Plowright.

Recent Experiments by Dr. Minks: "Lichens not parasitical Fungi or Algæ." (From 'Revue Mycologique.')

Diseases of Plants caused by *Peronosporæ*, Mode of Treatment, &c. Dr. Maxime Cornu. (From 'Comptes Rendus.')

Some Exotic Fungi. M. C. Cooke.

New British Lichens. Communicated by the Rev. J. M. Crombie, F.L.S.
Two Species of Peronospora. Prof. Passerini.
The Maple Disease (*Rhytisma acerinum*). Dr. Maxime Cornu. (From 'Comptes Rendus.')
Californian Fungi. M. C. Cooke.
The Dual-lichen Hypothesis.
Lichen Flora (Rev. W. A. Leighton's).
Observations on some Species of Neapolitan Fungi. Dr. O. Comes.
Micographia.
Addenda and Corrigenda to New Diatoms by Prof. P. T. Cleve.
Cryptogamic Literature.

HARDWICKE'S SCIENCE-GOSSIP, No. 170 (February) :—

Hints for the Young Microscopist. T. R. I. (2 woodcuts.)
On the Colours of Animals and the arrangement of Pigment in Lepidoptera. A. M. McAldowie, M.B., C.M. (6 woodcuts.)
Microscopy.—A Live Box (Albert Smith—2 woodcuts).—Newcastle Microscopical Society.—The Pygidium of Insects.

No. 171 (March) :—

Note on Preparing and Preserving delicate Organisms. G. du Plessis (translated by W. H. Dalton).
Physiological Character of Fenestella (*continued*). G. R. Vine. (11 woodcuts.)
On Mounting and Preserving the Larvæ of Butterflies and Moths. William Brewster.
Microscopy, Zoology, Notes and Queries.—Cavities in Quartz. (J. Clifton Ward.)—A Novel Air-pump for removing Air-bubbles in Slides. (Woodcut.) (A. Smith.)—How to remove Canada Balsam from Slides. (S. C. Hincks.)—New Forms of Camera Lucida. (Woodcut.) (F. Kitton.)—This Journal.—*Glyciphagus plumiger.* (A. D. Michael — J. Lambert.) — Division of the Pteropoda.—Fermentation.—Anemones in Aquaria. (G. L. B.)—A curious Crustacean. (Junior.)

MIDLAND NATURALIST, Vol. II., No. 14 (February) :—

Microscopy.—Postal Microscopical Society.—Mr. T. Bolton's Microscopical Agency.
Correspondence.—Snow Crystals.—Fresh-water Polyzoa.—Rotifers, &c.

No. 15 (March) :—

The Predaceous Water-Beetles (Hydradephaga) of Leicestershire. G. Robson.
Parasites of Man. T. Spencer Cobbold, M.D., F.R.S., &c.
A Lepidopterist's Notes on the Season of 1878. J. Anderson, jun.
Microscopy, &c.—Micro fungi and other Microscopical Preparations of Rev. J. E. Vize.—Snow Crystals under the Microscope.—Mounting Polyzoa and Rotifers.—Microscopic Camera-obscura, &c.
Reports of Societies.

MONTHLY JOURNAL OF SCIENCE, Third Series, Vol. I., No. 62 (February) :—

Compound Achromatic Microscope (Mr. J. Browning's). (1 woodcut.)
Zentmayer's reversable Diatom Stage.

No. 63 (March) :—

Spider's Web for Micrometers. (W. M. Williams, in 'Journal of the Society of Arts.')
Notes.—Biology.—Physics (Camera Lucida and Weber's Slide, in this Journal, vol. ii. part 1.—3 woodcuts—&c.).

NATURE, Vol. XIX. :—

January 16 :—*Biological Note:* On the Relations of Rhabdopleura. February 6 : — A Zoological Laboratory. — *Biological Notes.* — Caspian Sea Algæ. — On Sprouting in Isoetes.—The Brittle Stars of the 'Challenger.'—Spines of the *Echini.* February 13:—Research under Difficulties. February 20 :—*Letter to the Editor:*

The Gulf-weed (*Sargassum bacciferum*) a means of Migration for Fishes and Marine Invertebrates (J. M. Jones).—Sir John Lubbock on Ants. February 27:—*Biological Notes.*—Dredging Operations, Gulf of Mexico.—Asparagin in Plants. March 6:—The Morphology of the Echinoderms.

JOURNAL OF THE LINNEAN SOCIETY (Zoology), Vol. XIV., No. 77 (issued 31st January):—

On the Asteroidea and Echinoidea of the Korean Seas. W. Percy Sladen, F.L.S., F.G.S. (1 plate.)

On some Ophiuroidea from the Korean Seas. Prof. P. Martin Duncan, M.B. (Lond.), F.R.S., &c. (3 plates.)

The Anniversary Address of the President, Prof. Allman, M.D., LL.D., F.R.S.—Recent Progress in our Knowledge of the Structure and Development of the Phylactolæmatous Polyzoa.

TRANSACTIONS OF THE LINNEAN SOCIETY, Second Series, Botany, Vol. I., Part 6 (January):—

On *Mycoidea parasitica*, a new Genus of parasitic Algæ, and the part which it plays in the formation of certain Lichens. D. D. Cunningham, M.B., F.L.S., Surgeon H.M. Indian Army. (2 plates.)

On the occurrence of Conidial Fructification in the *Mucorini*, illustrated by *Choanephora*. By the same author. (1 plate.)

On the Self-fertilization of Plants. Rev. George Henslow, M.A., F.L.S., F.G.S. (1 plate.)

List of Fungi from Brisbane, Queensland, with Descriptions of New Species. Rev. M. J. Berkeley, M.A., F.L.S., and C. E. Broome, F.L.S. (2 plates.)

PROCEEDINGS OF THE ROYAL INSTITUTION OF GREAT BRITAIN, Vol. VIII., Part 4, No. 67 (January, 1878):—

Recent Researches into the Origin and Development of Minute and Lowly Forms of Life, with a glance at the bearing of these upon the origin of Bacteria. Rev. W. H. Dallinger, F.R.M.S.

Evolution of Nerves and Nervo-Systems. G. J. Romanes, M.A., F.L.S., &c.

Researches on the Deportment and Vital Resistance of Putrefactive and Infective Organisms from a physical point of view. Prof. Tyndall, LL.D., D.C.L., F.R.S.

Part 5, No. 68 (April, 1878). (Nil.)

PROCEEDINGS OF THE ROYAL SOCIETY, Vol. XXVIII., No. 191:—

On the Influence of Light upon Protoplasm. Arthur Downes, M.D., and Thomas P. Blunt, M.A. Oxon.

Note on the Influence exercised by Light on Organic Infusions. John Tyndall, D.C.L., F.R.S.

Report on Phyto-Palæontological Investigations generally, and on those relating to the Eocene Flora of Great Britain in particular. Dr. Constantin Baron Ettingshausen, Professor in the University of Graz, Austria.

No. 192:—

On some Points connected with the Anatomy of the Skin. George Thin, M.D. (1 plate and 4 figs.)

On Hyaline Cartilage, and Deceptive Appearances produced by Reagents, as observed in the Examination of a Cartilaginous Tumour of the Lower Jaw. George Thin, M.D. (5 figs. of a plate.)

On the Effect of strong Induction-Currents upon the Structure of the Spinal Cord. W. M. Ord, M.D., F.L.S., Fellow of the Roy. Coll. of Physicians, Physician to St. Thomas's Hospital.

Concluding Observations on the Locomotor System of Medusæ. George J. Romanes, M.A., F.L.S.

TRANSACTIONS OF THE ZOOLOGICAL SOCIETY, Part 11:—

On the Mechanism of the Odontophore in certain Mollusca. Patrick Geddes. (3 plates.)

Scotland.

SCOTTISH NATURALIST, Vol. V., No. 33 (January, 1879):—

Supplementary List of Fungi found within the province of Moray. Rev. J. Keith.

Description of new Scottish Lichens. J. Stirton.

Report of Cryptogamic Society's Exhibition of Fungi, 1878. Rev. J. Stevenson.

Ireland.

PROCEEDINGS OF THE ROYAL IRISH ACADEMY, Vol. III., Ser. II., No. 2 (November):—

On Hullite—a hitherto undescribed Mineral, &c. Edward T. Hardman, F.C.S., H.M. Geol. Survey. With Notes on the Microscopical Appearances, by Prof. E. Hull, M.A., F.R.S.

TRANSACTIONS OF THE ROYAL IRISH ACADEMY, Vol. XXVI. (Science), No. 17 (October):—

Report on the Acanthology of the Desmosticha (Haeckel). Part I. On the Acanthological Relations of the Desmosticha. H. W. Mackintosh, B.A., Senior Mod. in Nat. Sc., T.C.D. (3 plates.)

Australian Colonies.

PROCEEDINGS OF THE LINNEAN SOCIETY OF NEW SOUTH WALES, Vol. II., Parts 3 and 4 (issued 1878):—

On some Australian Shells, described by Dr. A. Gould. Rev. J. E. Tenison-Woods, F.G.S., &c., &c.

On some new Marine Shells. By the same author.

Descriptions of three new Species of *Helix* from South Australia. Prof. Ralph Tate.

On the Extra-tropical Corals of Australia. Rev. J. E. Tenison-Woods, F.G.S., F.L.S., &c., &c. (3 plates.)

On the Echini of Australia (Supplemental Note). By the same author.

Continuation of the Mollusca of the Chevat Expedition. J. Brazier, C.M Z.S., Corr. Memb. Roy. Soc., Tas.

Notes and Remarks on Mollusca recently found in Port Jackson and New Caledonia. By the same author.

Vol. III., Part 1:—

On an Australian variety of *Neritina pulligera*, Linn. Rev. J. E. Tenison-Woods, F.G.S., F.L.S., &c.

On a new Genus of Milleporidæ. By the same author.

On a new Species of *Psammoseris*. By the same author. (1 plate.)

On a new Species of *Desmophyllum* (*D. quinarium*). and a young stage of *Cycloseris sinensis*. By the same author.

On some Australian Littorinidæ. By the same author.

On the Power of Locomotion in the Tunicata. William Macleay, F.L.S.

JOURNAL AND PROCEEDINGS OF THE ROYAL SOCIETY OF NEW SOUTH WALES, 1877, Vol. XI. (issued 1878):—

On some new Australian Polyzoa. Rev. J. E. Tenison-Woods, F.G.S.; Hon. Memb. R. S. N.S.W., &c., &c. (2 woodcuts.)

On some Australian Tertiary Corals. By the same author.

A Synopsis of the known species of Australian Tertiary Polyzoa. R. Etheridge, jun., F.G.S., &c.

Reports from the Sections (in Abstract).—Section E. Microscopical Science.—Reports of Proceedings of May–Nov. Meetings.

Remarks on the Coccus of the Cape Mulberry. F. Milford, M.D., M.R.C.S., &c.

Notes on some Local Species of Diatomaceæ. G. D. Hirst.

TRANSACTIONS AND PROCEEDINGS OF THE ROYAL SOCIETY OF VICTORIA, Vol. XIV. (issued 11th July, 1878):—

On some new Marine Mollusca. Rev. J. E. Tenison-Woods, F.G.S., F.L.S., &c.

On the History of Palæozoic Actinology in Australia. R. Etheridge, jun., F.G.S.

United States.

AMERICAN JOURNAL OF MICROSCOPY, Vol. III., No. 12 (December):—

What can be done with a Cheap Microscope. (From 'Young Scientist.')

The Microscope in Medicine. Dr. S. M. Mouser.

The Use of the Microscope. Geo. E. Blackham, M.D. (From 'Cincinnati Medical News.')

The Microscopical Examination of Yeast popularly explained. (From 'London Brewers' Journal.')

Outlines of a Process for the Examination of Urine for Medical Purposes. Arranged by R. Hitchcock.

On Biotite as a Pseudomorph after Olivine. Prof. A. A. Julien.

Recent Progress in the Study of the Lower Order of Cryptogams (Sir Joseph Hooker's Presidential Address, R. S.).

Exclusive Publication of Society's 'Proceedings.'

The Micrometric Standard.

Review of King's 'Urological Dictionary.'

Melting Point of Fats.

Vol. IV., No. 1 (January):—

Structure of Coloured Blood-corpuscles. (Paper read before the 'New York Academy of Sciences,' by Prof. Elsberg, M.D.) (1 plate.)

Artificial Crystals of Gold and Silver. Albert H. Chester. (5 woodcuts.)

Trichinæ in Pork. (Report of Mr. Atwood and Dr. Belfield to Office Health Depart., Chicago.)

The Microscope in Medical Jurisprudence. (Paper read by President H. C. Hyde before the 'San Francisco Microscopical Society.')

Notes on Diatomaceæ from Santa Monica, California. (Paper by Mr. Chas. Stodder, read before the same Society.)

Microscopic Soirées.—An improved Method of exhibiting Objects. Geo. E. Fell.

A new Form of Collecting Cane. (1 woodcut.)

Microscopic Pond Life. (Paper read before the North Staffordshire (Eng.) Naturalists' Field Club, by Mr. T. S. Wilkins.)

Transactions of Societies.—San Francisco Microscopical Society, Nov. 7 and 21.—Microscopical Section, Troy Scientific Association (no date).—Buffalo Microscopical Club (Nov. 10 and 11).

Exchanges.

A new Rotifer. D. S. Kellicott. (1 woodcut.)

Volvox globator. (From 'Young Scientist.) (1 woodcut.)

Sizes of Gun Punches.

Tolles' $\frac{1}{75}$ Objective.

Trichina.

Transactions of Societies.—San Francisco Microscopical Society, Dec. 5 and 19.—Buffalo Microscopical Club, Jan. 14.

Exchanges.

AMERICAN JOURNAL OF SCIENCE AND ARTS, Third Series, Vol. XVII., No. 97 (January):—

Scientific Intelligence.—Botany and Zoology:—'Die Algen Flora des Weissen Meeres.' By Dr. C. Gobi.—'North American Fungi: Fungi Americani, Centuries I. and II.' By H. W. Ravenel and M. C. Cooke.—'North American Fungi.' By J. B. Ellis.—'The Early Types of Insects.' By S. H. Scudder.

No. 98 (February):—

Scientific Intelligence.—Botany:—Botanical Necrology of 1878—E. M. Fries (Upsal); L. Pfeiffer (Cassel); A. Murray (Edinburgh); A. Bloxam (England); F. V. Raspail (Paris); S. Kurz (Calcutta); M. Durieu (Bordeaux); C. Pickering (Boston, U.S.); M. Seubert (Carlsruhe); T. Thomson (England); G. Zanardini (Venice); R. de Visiani (Padua); B. C. Du Mortier.

AMERICAN NATURALIST, Vol. XIII., No. 1 (January):—

On certain Contrivances for Cross-Fertilization in Flowers. By Prof. J. E. Todd. (8 woodcuts.)

The Gemmule v. the Plastidule as the ultimate Physical Unit of Living Matter. J. A. Ryder.

Absorption of Water by the Leaves of Plants. A. W. Bennett, M.A., B.S., F.L.S.

Recent Literature.—Sars' Molluscan Fauna of Arctic Norway (W. H. Dall). —Packard's Guide to the Study of Insects.—Thomas's Noxious Insects of Illinois.

General Notes.—Zoology:—Amphioxus and Lingula at the Mouth of Chesapeake Bay.—Singular Habit of a Meloid Beetle (S. W. Williston).—New Carcinological Papers.—Collett's List of Norwegian Zoological Literature for 1877.

Microscopy.—Removal of Air from Microscopic Specimens (F. C. Clark).—Limits of Accuracy in Measurements with the Microscope (W. A. Rogers, from a paper read at the Nat. Micr. Congress).—The Society Screw.—Exchanges.

No. 2 (February):—

Instinct and Reason. F. C. Clark, M.D.

Recent Literature.—Brehm's Animal Life. (11 plates.)

Moseley's Structure of the Stylasteridæ.

General Notes.—Zoology:—A Gall-inhabiting Ant (W. H. Patton).— A Hummer's Meal (W. H. Ballou).—Recent Papers on Crustacea (J. S. Kingsley). —The Nebaliad Crustacea as Types of a new Order (A. S. Packard, jun.).

Microscopy.—Nucleated Red Corpuscles of Human Blood (J. Edwards Smith). —The Wenham Compressorium.—Exchanges.

No. 3 (March):—

Remarks on Fossil Shells from the Colorado Desert. R. E. C. Stearns. (12 woodcuts.)

Experiments with *Pyrethrum roseum* in killing Insects. W. L. Carpenter, U.S.A.

Recent Literature. — Gegenbaur's Elements of Comparative Anatomy.— Schmarda's Zoology.

Botany.—Aspidium boottii.

Geology and Palæontology.—The Nature of Eozoon.

Microscopy.—New Microscopical Societies.—American Quarterly Microscopical Journal.—Sale of a Microscopical Library.—Spring Clips.

AMERICAN QUARTERLY MICROSCOPICAL JOURNAL, Vol. I., No. 2 (January):—

New Rhizopods. Prof. W. S. Barnard, B.S., Ph.D. (1 plate.)

A Study of one of the Distomes. C. H. Stowell, M.D. (1 plate.)

On the probable Error of Micrometric Measurements. Edward W. Morley, M.D., Ph.D.

Standard Measures of Length. Prof. W. A. Rogers.

On the Fissure-Inclusions in the Fibrolitic Gneiss of New Rochelle. Alexis A. Julien. (1 plate and 1 woodcut.)

The Classification of the Algæ. Rev. A. B. Hervey, A.M. (1 plate.)

The Ampulla of Vater, and the Pancreatic Ducts in the Domestic Cat. Simon H. Gage, B.S. (1 plate.)

Practical Hints in Preparing and Mounting Animal Tissues. Carl Seiler, M.D. (2 woodcuts.)

Observations on several Forms of Saprolegnieæ (*concluded*). Frank B. Hine, B.S.

Classification of the simplest Forms of Life. B. Eyferth.

Editorial.

Microscopic Vision.—Yellow Fever.—A Letter from Professor Abbe.—Notes.—

Laboratory Notes and Queries (by S. H. Gage).—Digest of current Literature. —Microscopical Societies.—Book Notices.—Publications received.

Transactions of the New York Microscopical Society (January, 1879).

Mechanism by which *Echinorhynchus* anchors his Snout. J. D. Hyatt.

Euglena and Trachelomonas. R. Hitchcock.

Proceedings of Meetings of 4th Oct. and 1st and 13th Nov., 1878.

France.

Annales des Sciences Naturelles (Botanique), Sixth Series, Vol. VII., Nos. 1 and 2 (issued February, 1879):—

Researches on the Depazeæ. L. Crié. (8 plates.)

Studies on the Seminal Integuments of the Gymnospermous Phanerogams. C. E. Bertrand. (6 plates to follow.)

Observations on the Modifications of Plants according to the physical conditions of the medium. G. Bonnier and Ch. Flahault.

Brébissonia,—illustrated Monthly Review of Algology and Botanical Micrography. Edited by M. G. Huberson. Vol. I., No. 7 (January):

Spirogyra Lutetiana, n. sp., P. Petit. P. Petit. (1 plate.)

Some Remarks on the Diatomaceæ of P. T. Cleve and Möller. Upsal, 1878. Nos. 1–48. A. Grunow. (From 'Amer. Journ. of Microscopy.')

Diseases of Plants caused by *Peronospora*, &c. Disease of Lettuces called "Le Meunier." (Both by Max Cornu and from 'Comptes Rendus.')

Organization of *Hygrocrocis arsenicus*, Bréb. (By Prof. L. Marchand, from 'Comptes Rendus.')

Bibliography.—The Thallus of the Diatomaceæ. Dr. M. Lanzi.—Œdogoniæ Americanæ of V. B. Wittrock. *News.*

Journal de l'Anatomie et de la Physiologie de l'Homme et des Animaux, Vol. XV., No. 1 (January and February):—

Embryogeny of *Asteriscus verruculatus*. Dr. J. Barrois. (2 plates.)

Evolution and Structure of the Nuclei of the Elements of the Blood in the Triton. G. Pouchet. (1 plate.)

Study on the Lymphatics of the Skin. Drs. G. and F. E. Hoggan. (2 plates.)

Analysis of 'The Absorption of Colouring Matters by the Roots of Plants.' MM. Max Cornu and E. Mer.

No. 2 (March to April):—

The Parasitic Acarians of the Cellular Tissue and Air Reservoirs of Birds. P. Mégnin. (2 plates and 3 woodcuts.)

Contribution to the Study of the *Retinal Purple*. M. H. Beauregard. (1 plate.)

On the Employment of Wet Collodion for Microscopic Sections. Mathias Duval.

Journal de Micrographie, Vol. II., No. 9 (September): *—

Revue.—The National Congress of American Microscopists at Indianapolis.—Standard for Micrometric Measurements. — Various American (and Anglo-American) Books on the Microscope, and American Microscopical and other Journals.

Migration of Blood-corpuscles in passive Hyperæmia. Dr. W. T. Belfield. (Read at the Indianapolis Congress.)

A New Field for the Microscopist (*concluded*). W. Saville Kent.

Studies on the Schizomycetes. Oscar Brefeld.

National Micrographical Congress at Indianapolis. Dr. J. Pelletan.

No. 10 (October): *—

Revue.—M. G. Huberson's 'Brébissonia' and 'Practical Formulary of Photography with Silver Salts.'—The 'Zeitschrift für Mikroskopie,' and other German and American Journals.

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* For some reason which is unexplained, neither of these numbers were sent to the subscribers in this country, and it was not until No. 11 appeared that the omission was discovered.

The Lymphatic Hearts (*continuation*). Prof. Ranvier. (1 plate.)

Preliminary Note on the Development of the Blood and the Vessels (*conclusion*). Drs. V. Brigidi and A. Tafani.

Volvox globator. A. W. Bennett. (From 'Am. Jour. of Mic.' and 'Pop. Sc. Rev.')

New Oil-Immersion Objective of C. Zeiss, of Jena. W. H. Dallinger. (Taken from 'Nature,' vol. xviii.)

Microscopical Technic.—Preparation of whole Insects without pressure for the Binocular. S. Green. (From 'Jour. Quekett Mic. Club.')

Vol. III., No. 1 (January):—

Revue.—The 'Revue des Sciences Naturelles' of Montpellier.—The 'Recueil de Médécine Vétérinaire.'—The 'Bulletin de la Société Belge de Microscopie,' and American Journals.

The Muscles of the Œsophagus. Prof. Ranvier.

Researches on Spermatogenesis studied in some pulmonate Gasteropoda. Dr. M. Duval. (1 plate.)

Angular Aperture of Microscope Objectives (*continuation*). Dr. G. E. Blackham. (1 plate.)

Diatoms of the Archipelago of the West Indies (*continuation*). Prof. P. T. Cleve. (12 woodcuts.)

Histological Microscope of Mr. C. Collins. (1 woodcut.)

On the Formation of the Spores of the Mesocarpeæ. E. Perceval Wright. (From 'Nature,' vol. xviii.)

Bibliography.—Researches of M. Van Tieghem on the Mucorini. By A. Faure.

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Fecundation in the Vertebrates. Prof. Balbiani.

Angular Aperture of Microscope Objectives (*continued*). Dr. G. E. Blackham. (1 plate.)

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Method of Studying the Embryo of Fishes. M. F. Henneguy. (From 'Bull. Soc. Phil.,' Paris.)

Diatomaceæ of the West Indian Archipelago (*continued*). Dr. P. T. Cleve. (14 woodcuts.)

Note on some Diatoms. F. Kitton. (From 'Bull. de la Soc. Belge de Micr.')

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The Myxogastres. Dr. L. Quélet.

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The Preservation of Fungi from a scientific point of view. The Editor.

Microscopic Studies and Preparations of Fungi.—Microscopic Slides of the Rev. J. E. Vize.—Photographic Microscope of Dr. Ch. Fayel. The Editor.

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Comptes Rendus, Vol. LXXXVIII., No. 1 (6th January):—

Reply to M. Pasteur. M. Berthelot.

On a Giganic Isopod of the Deep Sea. M. Alph. Milne-Edwards.

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No. 2 (13th January):—

Do there exist among the lower Organisms species exclusively aërobian and others anaërobian, &c. M. Trécul.

Observations on the Communication of M. Trécul, by M. Pasteur.

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New Observations on the Development and Metamorphoses of Tænias. M. P. Mégnin.

No. 3 (20th January):—

Observations on the Second Reply of M. Pasteur. M. Berthelot.

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On the Special Apparatus of Nutrition of Phanerogamous Parasitic Species. M. Chatin.

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Third Reply to M. Berthelot. M. Pasteur.

On the Composition of the Banana, and on attempts at utilizing this Fruit. MM. V. Marcano and A. Muntz.

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Researches on the Physiological Action of *Grenat* or residue of the manufacture of Fuchsine. M. Jousset de Bellesme.

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The Influence of Duration and Intensity on Luminous Perception. MM. Ch. Richet and Ant. Breguet.

The Intimate Structure of the Central Nervous System of Decapod Crustacea. M. E. Yung.

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Researches on the Acinetæ of the Coast of Ostend. Parts 2-4. M. Julien Fraipont. (4 plates.)
Second additions to the Synopsis of the Cordulinæ, and List of those described in the Synopsis and its two additions. M. Edm. de Selys Longchamps.
On a new Species of Crustacea of the Coalfield of Belgium. Dr. L. G. de Koninck; being a translation of a paper, "Discovery of a Species of Brachyuran Decapod in the Coalfield of the environs of Mons," sent by Dr. H. Woodward, F.R.S., F.G.S., F.Z.S. (1 plate and 1 woodcut.)
Researches on the Development of the Inferior Jaw-bone of Man. M. H. Masquelin. (2 plates.)
Contribution to the Physiology of the Vagus Nerve of the Frog. MM. F. Putzeys and A. Swaen.
Researches on the Venomous Apparatus of the Chilopodan Myriapoda; Description of true Poison Glands. M. Jules MacLeod. (1 plate.)

Vol. XLVI. (July to December):—

Discovery of Brachiopoda of the Genus *Lingula*. M. C. Malaise.
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A word on the Gregarinæ, by M. Alex. Foettinger.

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Development of some Venezuelan Butterflies after the Observations of Gollmer. Dr. H. Dewitz. (1 plate.)

Minor Fragments on the Comparative Anatomy of the Arthropoda. G. Haller. (1 plate.)

Contributions to the Natural History of the Invertebrate Animals of Kerguelensland. Prof. Th. Studer. (3 plates.)

Part 2:—

New List of the Animals on which parasitic Insects live. Gurlt, with additions by Schilling.

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On the Organization of the Genera Axine and Microcotyle. Ludwig Lorenz. (3 plates.)

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** These pages are supplied for insertion after page 210, with the view of making the Bibliography for 1879 as uniform as it can now be made.

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Comptes Rendus, LXXXVIII., Nos. 3 & 6.
WILLIAMS, C. F. W. T.—*See* Microscopy.

Muscineæ.

BESCHERELLE, EM.—Note on three New Species of Mosses of New Caledonia, belonging to the Genus *Pterobryella* C. Müll.
Bull. Soc. Bot. France, XXV., Part 1.

Vascular Cryptogams.

BAUKE, H.—Reply to Dr. Prantl's Article on the Arrangement of the Cells in Flask-shaped Prothallia of Ferns. *Flora*, XXXVII., No. 1.
GOEBEL, K.—On Sprouting in the Leaves of Isoëtes. 4 figs.
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MICROSCOPY, &c.

ADAN, H. P.—The Invisible World Revealed. Parts 1 to 8. 16 plates. 8vo. Brussels and Paris, 1879.
American Quarterly Microscopical Journal. *Am. Nat.*, XIII., No. 3.
BEDWELL, F. A.—The Oil-Immersion $\frac{1}{8}$ inch. *Midl. Nat.*, II., No. 13.
BLACKHAM, Dr. G. E.—Angular Aperture of Microscope Objectives (*contd.*). 2 plates. *Journ. de Micr.*, III., Nos. 1 & 2.
BREWSTER, W.—On Mounting and Preserving the Larvæ of Butterflies and Moths. *Sci.-Gossip*, No. 171.
BROWNING'S Compound Achromatic Microscope. 1 fig.
M. Journ. Sci., I., No. 62.
CERTES, A.—On a Method of Preserving Infusoria.
Comptes Rendus, LXXXVIII., No. 9.
CHESTER, H.—Artificial Crystals of Gold and Silver. 5 figs.
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CLARK, F. C.—Removal of Air from Microscopic Specimens.
Am. Nat., XIII., No. 1.

CLINCH, G.—A new Lamp for Microscopic Mounting. *Sci.-Gossip*, No. 169.
COLE & SON, Cabinet of Microscopy of. *Journ. de Micr.*, III., No. 2.
COLLINS, C., Histological Microscope of, 1 fig. „ „ „ No. 1.
CORNET, M.—The Rivet Microtome. *Bull. Soc. Belg. Micr.*, V., No. 4.
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DUVAL, M.—On the Employment of Wet Collodion for Microscopic Sections. *Journ. Anat. et Phys.* (*Robin*), XV.) No. 2.
FELL, G. E.—Microscopic Soirées — An Improved Method of Exhibiting Objects. *Am. Journ. Micr.*, IV., No. 1.
[FORREST, H. E.]—Apparatus for Drawing Objects under the Microscope. *Midl. Nat.*, II., No. 13.
HAGER, Dr. H.—The Microscope and its Employment. 6th Ed. 231 figs. 8vo. Berlin, 1879.
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HYDE, H. C.—The Microscope in Medical Jurisprudence. *Am. Journ. Micr.*, IV., No. 1.
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KITTON, F.—New Forms of Camera Lucida. 1 fig. [Hofmann's.] *Sci.-Gossip*, No. 171.
LANKESTER, Prof. E. R.—[Microscopical] Research under Difficulties. *Nature*, XIX., No. 485.
Microscopical Library, Sale of a. *Am. Nat.*, XIII., No. 3.
MORLEY, E. W., M.D., Ph.D.—On the Probable Error of Micrometric Measurements. *Am. Quar. Micr. Journ.*, I., No. 2.
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ROGERS, Prof. W. A.—Limits of Accuracy in Measurements with the Microscope. *Am. Nat.*, XIII., No. 1.
„ „ Standard Measures of Length. *Am. Quar. Micr. Journ.*, I., No. 2.
ROUMEGUÈRE, C.—The Microscopical Study and Preparation of Fungi. *Rev. Mycol.*, I., No. 1.
„ „ Microscopical Slides of Fungi of the Rev. J. E. Vize. *Rev. Mycol.*, I., No. 1.
SEILER, CARL, M.D.—Practical Hints in Preparing and Mounting Animal Tissues. 2 figs. (*In part.*) *Am. Quar. Micr. Journ.*, I., No. 2.
SMITH, A.—A Live Box. 2 figs. *Sci.-Gossip*, No. 170.
„ „ A Novel Air-pump for removing Air-bubbles in Slides. 1 fig. *Sci.-Gossip*, No. 171.
„ „ New Form of Collecting-cane. 1 fig. *Am. Journ. Micr.*, VI., No. 1.
SMITH, J. EDWARDS, M.D.—[Beck's Vertical Illuminator.] *Am. Nat.*, XIII., No. 2.
Society Screw. „ „ No. 1.
Spring Clips (Hawley's). „ „ No. 3.
THIN, G.—*See* Zoology A.
TOLLES' $\frac{1}{75}$ Objective. *Am. Journ. Micr.*, IV., No. 1.
WATSON AND SON, Student's Microscope of. *Journ. de Micr.*, III., No. 2.
WILKINS, T. S.—Microscopic Pond Life. (Paper read before the "North Staffordshire Naturalists' Field Club.") *Am. Journ. Micr.*, IV., No. 1.
WILLIAMS, C. F. W. T.—On Mounting Micro-Fungi. 1 fig. *Sci.-Gossip*, No. 169.
Williams, W. M.—Spider's Web for Micrometers. (From 'Journ. Soc. Arts.') *M. Journ. Sci.*, I., No. 62.
ZENTMAYER'S Reversible Diatom Stage. „ „

PROCEEDINGS OF THE SOCIETY.

ANNUAL MEETING OF 12TH FEBRUARY, 1879, AT KING'S COLLEGE, STRAND, W.C.

H. J. Slack, Esq., President, in the Chair.

The Minutes of the meeting of 8th January last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Brewer, J. A.—Flora of Surrey. 1863	*Mr. Crisp.*
Chester Society of Natural Science—Proceedings. No. 2. 1878	*Mr. Thos. Shepheard.*
Drysdale, J., M.D.—The Germ Theories of Infectious Diseases. 1878	*The Author.*
Hoggan, G. and F. E.—Étude sur les Lymphatiques de la Peau. (Extracted from the 'Journal de l'Anatomie and de la Physiologie')	*The Authors.*
Koerber, Dr. G. W.—Systema Lichenum Germaniæ. 1855	*Mr. Crisp.*

The President read his Address (see p. 113).

Dr. Matthews said that the President, at the commencement of his address, had stated that he could hardly hope to rival that delivered at their previous anniversary by Mr. Sorby, but he was sure that all present would agree that they could not have had laid before them more interesting and important matters than those which had been dealt with that evening, and he had great pleasure in moving that the cordial thanks of the meeting be given to the President for his address, and that it be printed and circulated in the usual way.

Dr. W. J. Gray having seconded the motion,

Dr. Matthews put it to the meeting, and declared it to be carried unanimously.

The President then read a copy of a letter which he had addressed to the Council as to his reasons for not offering himself for re-election for another year, which was followed by remarks from Mr. Crisp and from Dr. Matthews on behalf of the Council.

Mr. C. Brooke, F.R.S., then took the chair.

The Report of the Council was read by the Junior Secretary, Mr. Crisp (see p. 216), various passages being received with demonstrations of approval from the meeting.

Mr. Glaisher, F.R.S., said he rose with a great deal of pleasure to

move the adoption of the report. Having long been connected with the Society, and having always taken a lively interest in its welfare, it was indeed a source of pleasure to him to find that it now had a larger annual income than at any previous time, which, coupled with the fact that it had upwards of 2100*l.* to the credit of capital, was of itself full evidence that the Society was prospering and flourishing.

With regard to the Journal, it was impossible for him to look back upon the past without recalling how the late Rev. J. B. Reade, Dr. Bowerbank, and himself had always worked together to secure to the Society an independent Journal, not connected in any way with the interests of trade. They had that now, and he had seen the recent numbers with the greatest satisfaction, and could read them again and again.

When he had the honour some years ago of filling the Presidential chair, he had suggested that they should take means for bringing kindred societies into closer connection with themselves. His idea then was that the Societies should pay 10*s.* a year, or some such arrangement. The fact that a proposition was to be brought forward now to connect these kindred societies was particularly pleasing to him. Their own object was to diffuse and encourage microscopical study and inquiry, and there were many excellent workers amongst the provincial societies in this country, whom it would be honourable to the Society to recognize. It was therefore with very much more than usual pleasure that he moved "That the Report be received and adopted, and that it be printed and circulated in the usual way."

Mr. T. Charters White had much pleasure in seconding the resolution which had been so warmly spoken to by Mr. Glaisher, and he cordially approved of the proposal in regard to other societies.

The Chairman having put the motion, declared it carried unanimously.

Mr. Crisp then moved the following amendment to the Bye-laws:—

"I. The 1st Bye-law shall read as follows:—

1. The Society shall consist of Fellows, and Ex-officio, Honorary, and Corresponding Fellows and Associates.

II. The following Bye-law shall be inserted after No. 15 *a*, to be numbered No. 15 *b*:—

15 *b*. The Ex-officio Fellows shall consist of the Presidents for the time being of such Societies at home or abroad as the Council may from time to time recommend and an ordinary or annual meeting may approve. During their term of office they shall be entitled to receive the publications of the Society and to exercise all other privileges of Fellows except that of voting, but shall not be required as Ex-officio Fellows to pay any entrance fee or annual subscription."

He said that after having laid his proposition as to Ex-officio Fellows before the members of the Council and obtained their approval of it, he had canvassed the matter amongst such of the Fellows generally as he had been able to meet with during the past

two months, and the only difficulty that he had experienced was that it was too uniformly approved. He spoke of that as a "difficulty" because it was always desirable when what might be termed radical changes were mooted, that both sides of the question should be placed before the meeting, which was thereby enabled to come to a sounder decision. At the eleventh hour, however, he had been able to meet with a Fellow who entertained some objections.

Mr. J. W. Stephenson having seconded the motion,

Mr. Curties said that his objection to Mr. Crisp's proposal might be stated in a word. He thought, as Mr. Glaisher had put it, that the societies should pay a small subscription, as it was intended that they should receive the Journal free of charge. It seemed to him that if they were to be giving their valuable Journal in perpetuity in this way, they might some day have cause to be sorry for it. Whether this liberality was justified by their present prosperity he would not venture to say, but it should be remembered that at the present time their Honorary Fellows did not receive the Journal.

A further discussion ensued, in which Mr. T. C. White, Mr. James Smith, Dr. Braithwaite, and others took part, after which the Chairman put the motion to the meeting and declared it to be carried unanimously.

Mr. Stephenson, the Treasurer, presented his accounts for the year 1878 (see p. 218).

Dr. Braithwaite moved that the accounts be received and adopted, and printed and circulated as usual, which was seconded by Mr. Glaisher, and carried unanimously.

The List of Nominations for the Council was then read, and the Chairman nominated Mr. A. D. Michael and Mr. T. C. White Scrutineers.

The Scrutineers having handed in their report of the result of the ballot,

The Chairman announced that the following Fellows (being those whose names appeared in the list of nominations) were duly elected:—

President—* Lionel S. Beale, Esq., M.B., F.R.S.

Vice-Presidents—* Robert Braithwaite, Esq., M.D.; Charles T. Hudson, Esq., M.A., LL.D.; * Henry J. Slack, Esq., F.G.S.; and Henry C. Sorby, Esq., F.R.S., Pres. G.S.

Treasurer—John Ware Stephenson, Esq., F.R.A.S.

Secretaries—Charles Stewart, Esq., M.R.C.S.; Frank Crisp, Esq., LL.B., B.A.

Twelve other Members of Council—John Badcock, Esq.; William A. Bevington, Esq.; Charles James Fox, Esq.; * James Glaisher, Esq., F.R.S., F.R.A.S.; *A. de Souza Guimaraens, Esq.; William J. Gray, Esq., M.D.; * John E. Ingpen, Esq.; Emanuel W. Jones, Esq., F.R.A.S.; * William T. Loy, Esq.; John Matthews, Esq., M.D.; John Millar, Esq., L.R.C.P.E.; and Thomas Palmer, Esq., B.Sc.

* Have not held during the preceding year the office for which they were nominated.

Dr. Lionel S. Beale, M.B., F.R.S., was then called upon by Mr. Brooke to take the chair as President of the Society, and in doing so was received with loud and long-continued cheering. He said that he felt deeply indebted to the Society for the honour which they had done him in electing him their President, and for the warmth with which he had been received. It would be his duty as well as his pleasure to come amongst them as often as possible, and as he had for some years paid comparatively little attention to the Microscope, he expected to learn a great deal by attending the meetings.

Mr. Stephenson said he had received from Professor Abbe some photographs of *Amphipleura pellucida* and *Pleurosigma angulatum*, which had been sent to him by Dr. Woodward, together with a letter containing Dr. Woodward's opinion of the oil-immersion objectives (part of the letter was read, see p. 140, and the photographs were handed round).

A Letter was read from Mr. Badcock, in which he pointed out that in the report of the meeting of 11th December last, he was made to say, in reference to *Œcistes umbella*, "at which time he showed it to Mr. Oxley." What he said was that he had had a sketch made of it at the time, which he had recently shown to Mr. Oxley.

Mr. Crisp said that a grave charge had been made against him, which really belonged to the Society, and he would therefore take this opportunity of transferring it to the right shoulders. It was said that when a large and complicated form of Microscope was made, it was invariably brought to the Society and exhibited, but that they never exhibited any of the smaller and cheaper forms from time to time produced—that out of 1000 microscopists, however, 999 used the latter instruments, and only the one man in the 1000 the former, so that they failed somewhat in their duty in not giving at least equal encouragement to what it was contended was the more useful instrument in the strict sense of the term. He must say (speaking entirely for himself) that he thought this suggestion was not without force, and by way of doing penance for his own shortcomings he had brought, and begged to present to the Society, three of the recent smaller instruments—the "Model" of Messrs. Baker, the "Binocular Economic" of Messrs. Beck, and the "Alpha" School Microscope of Mr. Crouch.

Mr. Stephenson said that if Mr. Crisp was not tired of receiving the thanks of the Society he should like to move a vote of thanks to him for his valuable presents.

Dr. Braithwaite having seconded the motion, it was put to the meeting and carried unanimously.

The following were exhibited:—

Mr. Badcock:—Three lithographs of Infusoria on a black ground, illustrating a new method.

Mr. T. J. Parker:—Slides of Copepoda, prepared with osmic acid.

Mr. Stephenson:—(1) Five forms of his catoptric immersion illuminator, viz.:—

Three of 1-inch, $\frac{1}{2}$-inch, and $\frac{1}{4}$-inch radius, as described in this Journal, vol. ii. p. 36.

A cylindrical illuminator of 1-inch radius on the same principle.

A fifth consisting of two lenses, a meniscus and plano-convex, the curvature of the latter coinciding with the curved surface of the former, so that the achromatism is preserved whilst there is no interference with the power of total reflection at the surface where the film of air between the lenses intervened.

(2) The following photographs taken by Dr. Woodward (lent by Professor Abbe):—

Amphipleura pellucida, in balsam. Zeiss' $\frac{1}{12}$ oil immersion (2630 diameters).

Same valve. Zeiss' $\frac{1}{8}$ oil immersion, with Tolles's amplifier (2500 diameters).

Same valve. Powell and Lealand's $\frac{1}{25}$ water immersion (2780 diameters).

Same valve. Powell and Lealand's new $\frac{1}{16}$ water immersion (2565 diameters).

Same valve. Spencer's $\frac{1}{10}$ glycerine immersion, with Tolles's amplifier (2440 diameters).

Pleurosigma angulatum (hexagons). Zeiss' $\frac{1}{12}$ oil immersion (2400 diameters).

Same (diffraction lines—Abbe's experiment). Zeiss' $\frac{1}{8}$ oil immersion (1700 diameters).

Mr. Ward:—(1) Sections (double stained) of stem of Gulancha (*Tinospora cordifolia*). (2) Sections (double stained) of stem of *Rhipsalis Cassytha* (Cactaceæ).

Mr. Crisp:—(1) Baker's "Model" histological Microscope. (2) Beck's small binocular Microscope on the "Economic" principle, with American glass stage. (3) Crouch's "Alpha" school Microscope, with dividing object-glass. (4) Professor Möbius's elaborate treatise on "The Structure of Eozoon Canadense." (5) The preparations of whole insects of Herr Petzold, of Vienna, described in 'Nature,' vol. xix. (1879) p. 301, and lent by the editor.

New Fellows.—The following were elected Fellows of the Society, viz.:—Messrs. T. Brown; L. Dreyfus; C. A. Lucas; W. M. Marshall J.P.; and T. J. Parker, Assoc. R.S.M.

REPORT OF THE COUNCIL

PRESENTED TO

THE ANNUAL MEETING.

General Position of the Society.

In presenting their Report at the close of the 40th year of the Society's existence the Council have much pleasure in congratulating the Fellows upon its continued and increasing prosperity and vitality.

The number of Fellows is now 437. Eleven were elected during the past year in excess of the number elected in 1877, and twelve nominations for Fellowship have been received since the beginning of this year.

Finances.

The Finances of the Society are in a very satisfactory condition. The Annual Income is now larger than at any previous time; whilst as regards Capital, the funds invested in Consols and India Stock, together with the Cash in hand, amount to upwards of 2100*l.*, as will be seen from the Treasurer's Accounts presented with this Report.

New Rooms.

The Council are glad to be able to announce that negotiations are pending with the authorities of King's College, by which it is anticipated that the Society will have the use of more commodious and convenient rooms.

Library, Instruments, &c.

The Council thought it prudent to limit the expenditure during the past year on the Library, Instruments, and Apparatus, on account of the difficulty that existed in forming any reliable estimate of the probable cost of the Journal, but now that that expenditure has been ascertained, and having regard to the amount of the Society's Capital, they see no reason why the full surplus of Income should not be annually expended in additions to the Library and Apparatus, leaving only the composition fees to accumulate in future for the benefit of the Capital Account.

Several valuable additions have, however, been made to the Library during the past year, including (from Mr. Crisp) 27 volumes of the 'Annales des Sciences Naturelles,' 10 volumes of the 'Zeitschrift für wissenschaftliche Zoologie,' and 6 volumes of 'Grevillea,' together with other works. The Council have also accepted from the same Fellow a Cabinet for the Instruments, &c., and additions have been made to the Apparatus and Objects.

A detailed and very complete Catalogue of the Instruments and Apparatus has been made by Mr. Fox. The revision of the Library Catalogue, and the re-arrangement of the Books according to subjects was also determined upon, but these matters have necessarily been postponed in consequence of the contemplated change of rooms.

Journal.

The Council have been gratified to learn that the new series of the Journal has met with general approval. A leading feature of the Journal (apart from the Transactions and Proceedings of the Society) consists of Notes of the observations and investigations of interest in Biology which are recorded in the Publications of the principal Academies and Learned Societies throughout the world, or in the other serial publications of this and other countries.

The Council find that this plan is looked upon with satisfaction, not only by those Fellows who, from being resident in the provinces, are unable

to obtain access to many of the works through which such observations are scattered, but also to the Fellows and Biologists generally in London, who, apart from the fact of the original communications being in most cases in a foreign language, are assisted in their researches by having the salient points of recent investigations collected together in a condensed form.

One of the Secretaries has kindly undertaken (as an honorary office) the Editorship of the Journal.

Business at the Meetings.

The Council are of opinion that it would be useful, in the best sense of the term, that any important observations in Biology made by Foreign Observers should be noticed at the Meetings, and with this view they have requested the Secretaries to bring to the notice of the Meetings any such observations, illustrated by drawings where possible. The Council will be glad to receive the co-operation of other Fellows in carrying out this object.

The Council have taken into consideration the necessity of making some alteration in the proceedings at the Meetings, so as to avoid their being protracted to the late hour that has lately been rendered necessary by the pressure of business to be disposed of, and they think that a sufficient remedy will be found in providing that Papers shall not be read *in extenso*, except in special cases. They hope that by this means it may be found possible to conclude the business by half-past nine, leaving a longer period for tea and coffee, conversation and the examination of the objects exhibited.

Association of kindred Societies.

A suggestion has been made to the Council that some plan should be devised by which other Societies founded for kindred objects should be brought into association with this Society. It would not of course be possible to provide that the Members of other Societies should *ipso facto* be entitled to the privileges of Fellows, but the Council propose that the Presidents for the time being of such kindred Societies at home or abroad as the Council may from time to time recommend, and the Fellows at an Ordinary or Annual Meeting approve, shall be *ex-officio* Fellows, being entitled to receive the 'Journal' on behalf of their Societies, and to exercise all other privileges of Fellows except voting. The Council do not propose that this should be limited to those bodies which include in their title the term "Microscopical" (a term which, as applied to Societies mainly devoted to Biological and Histological investigations, has now lost most of its original import), but should include all whose principal object is Biological Research in any of its branches.

An amendment of the Bye-laws will be proposed at the Meeting to enable this to be carried into effect.

Quekett Fund.

The Council have turned their attention to the disposal of the Quekett Fund, which has now accumulated at interest for some years until it amounts (taking the cash value) to upwards of 180*l.*

The Council have determined to recommend to the Annual Meeting that a sum shall be applied in the purchase of books (not reducing the fund below 100*l.*), the balance being invested, and the income of the investments expended annually for a similar purpose, the books to bear an inscription indicating the source from which they were purchased. The Council consider that in this way the Fund will be applied in the most suitable manner, as regards utility to the Fellows and the perpetuation of the memory of the President, in whose honour it was formed.

THE TREASURER'S ACCOUNTS FOR 1878.

Dr.

1878.	£	s.	d.
To Balance brought forward 31st December, 1877	254	18	6
„ One Year's Dividend on 1778*l*. 18*s*. 6*d*. Consols	52	9	7
„ Compositions	73	10	0
„ Annual Subscriptions, &c.	418	2	0
„ Journals sold *	22	11	9
	£821	11	10

Cr.

1878.	£	s.	d.
By 'Monthly Microscopical Journal' for 1877	27	0	0
„ Journal of the Society, Vol. I., Nos. 1 to 6	304	8	2
„ Rent and Attendance at King's College	68	16	0
„ Mr. Reeves' Salary	80	0	0
„ „ „ Commission	12	4	0
„ Reporter	6	6	0
„ Books and Journals	12	13	0
„ Bookshelves	4	18	8
„ Printing Circulars, &c.	14	3	6
„ Fire Insurance	1	4	0
„ Petty Cash, including Postages	30	4	2
„ 77*l*. 2*s*. Consols	73	10	0
„ Balance remaining 31st December, 1878 *	186	4	4
	£821	11	10

* Exclusive of sales of Nos. 3 to 6 of the Journal.

Investments (31*st December*, 1878).

3 per cent. Consols, 1856*l*. 0*s*. 6*d*.

5 per cent. India Stock (Quekett Fund), 134*l*. 1*s*. 3*d*. (in addition to 9*l*. 18*s*. uninvested Interest).

Examined and found correct,

THOMAS CURTIES.
JAS. W. GOODINGE.

30th January, 1879.

MEETING OF 12TH MARCH, 1879, AT KING'S COLLEGE, STRAND, W.C.
THE PRESIDENT, DR. BEALE, F.R.S., IN THE CHAIR.

The Minutes of the meeting of 12th February were read and confirmed, and were signed by the President.

The President said that the amount of business on the agenda that evening was so great that it would be necessary to compress the different matters as much as possible, or they would not be able to include them all.

The following Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors:—

	From
Corden, G.—The Meteorology of Croydon. 1878.	*The Croydon Mic. and Nat. Hist. Club.*
Harting, P.—Recherches de Morphologie synthétique sur la production artificielle de quelques Formations Calcaires Organiques. 1872	*The Author.*
Rabenhorst, Dr. L. — Deutschland's Kryptogamen - Flora. 1844–5	*Mr. Crisp.*
Siddall, J. D., and H. B. Brady.—Catalogue of British Recent Foraminifera, for the use of Collectors. 1878	*The Authors.*

Four slides of "Fossil Diatoms" from Richmond, Va., Petersburg, Va., and Nottingham, M.D. (U.S.), were presented by Mr. C. L. Peticolas, through Mr. A. Allen, the Secretary of the Postal Microscopical Society.

Mr. Crisp mentioned that he had arranged with Mr. Bolton to send him a supply of living specimens, which he would bring to the Wednesday evening meetings, and would be glad to continue the arrangement if it were found that the Fellows made use of it.

Lists of Nominations under the new Bye-law relating to Ex-officio Fellows and of Honorary Fellows were read by the President.

The President announced the completion of arrangements with the authorities of King's College for the occupation by the Society of the room in the south corridor.

Mr. A. D. Michael gave an abstract of his paper, "A Contribution to the Knowledge of British Oribatidæ," accompanied by two large coloured drawings and four slides.

The President invited observations upon Mr. Michael's paper, and remarked that there was a great deal of interest connected with the circumstance he mentioned as to the apparent ability of these creatures to perceive light without being possessed of eyes. There were evidences to be found amongst the higher animals of a power of receiving impressions of light without the aid of an ophthalmic organ.

Mr. T. J. Parker inquired if Mr. Michael had found out anything

as to the nature of the white powder mentioned as being found upon one species of the mites?

Mr. Michael said that he had little doubt as to the use of this powder, which seemed clearly to be of a protective character. Many other species not provided with powder, made a similar protection for themselves by rolling in the mud. As to its origin, he was unable to say anything with certainty, but thought that the cast skins had something to do with it.

The thanks of the meeting were given to Mr. Michael for his paper.

Dr. George Hoggan read parts of a paper "On the Development and Retrogression of Fat-Cells," in which the results of a series of observations and experiments carried out by himself and Mrs. Hoggan were minutely detailed. The subject was well illustrated by preparations exhibited under twelve Microscopes in the room.

The President, in proposing a vote of thanks (which was carried unanimously) for Dr. Hoggan's very interesting communication, said that so many points of interest had been referred to that a great deal of time would be needed to discuss it thoroughly.

Mr. Beck placed upon the table and described in detail a new large binocular Microscope which he had devised with swinging bar for condenser, mirror, and lamp, and with improved movements, and invited the Fellows to criticise it freely at the close of the meeting, with a view to its possible further improvement.

Mr. Crisp, in calling attention to the new $\frac{1}{18}$ oil-immersion objective of 1·26 numerical aperture (or the large balsam angle of 114° 18′), said that they had a very interesting communication from Professor Abbe on oil-immersion objectives in general, which there was unfortunately no time to read, but of which he would briefly mention the chief points.

In the first place, the Society would be pleased to find that Professor Abbe had given full credit to England, and to this Society in particular, in regard to the origination of these objectives, his paper read before the Jena Society being entitled "On Stephenson's System of Homogeneous Immersion for Microscope Objectives."

Professor Abbe had also turned his attention to finding *aqueous* fluids fit for homogeneous immersion, and believed that "*distilled* chloride of zinc dissolved in water will prove to be an excellent substitute for the oil of cedar wood. It does not dissolve balsam, and can be cleared off by water, and does not flow like the cedar-oil; its consistence is like thick olive oil." Professor Abbe added that he is making experiments with other preparations, from which he expects good results.

A third point related to a suggestion recently made by Mr. Stephenson that, looking to the large working distance of the oil-immersion system and the optical homogeneity of crown glass and the immersion fluid, the front lens of the objectives, instead of being held

in place by the brass setting (whereby necessarily a greater or less part of the periphery of the lens was rendered ineffective), should be fixed by balsam to a thin plate of parallel glass rather larger than the lens, the plate itself being attached by its periphery to the brass mounting. Professor Abbe, in reply, said that he had last summer tried the plan with perfect success in some experiments made to test its efficiency, and that several $\frac{1}{8}$ths had been so constructed. The device necessarily introduced a very delicate additional point into the optical system (the balsam film), and it would not be prudent to apply it where it is not absolutely necessary, but it was the only way, in his opinion, by which an objective of 1·35 numerical aperture ($=128\frac{1}{3}°$ balsam angle) could be made, and he hoped before long to accomplish this.

Mr. Wenham said he should like to observe, with reference to the proposed method of fixing the front lens, that Mr. Tolles about eight years ago constructed an objective in which the front was fixed in a similar way.

Mr. J. Mayall, jun., said that he had examined the new $\frac{1}{18}$ oil-immersion belonging to Mr. Crisp, and had measured the aperture with the Abbe apertometer. He found it slightly less than the figure which had been mentioned. As to flatness of field, it did not show that as he should have expected to see it in similar powers by Powell and Lealand or by Tolles. Whether flatness of field was a desirable quality or not, he would not engage to decide; it was, at any rate, a quality much sought for by certain opticians. The lens was specially designed for immersed objects or for objects in close contact with the cover-glass, and when used on such objects gave fine definition. With an immersion illuminator he had seen the striæ of *Amphipleura pellucida* in balsam by lamplight with this lens more easily than with any other he had examined.

Mr. T. J. Parker read a paper by himself, "On some Applications of Osmic Acid to Microscopical Purposes," illustrated by four slides.

The President said that the Society was much obliged to Mr. Parker for bringing the method described before them, as it appeared from the specimens exhibited to be a very excellent one.

Mr. Crisp said that some little misconception seemed to exist in America as to the discussion at the October meeting on a unit of micrometry. At the end of that discussion Dr. Edmunds made some remarks on the Society's standard screw *for objectives*. This had apparently been supposed to refer to a "Whitworth screw carefully kept in the custody of the Society" as a standard *for micrometric measurements*, and was so referred to in an article by Professor Rogers in the January number of the 'American Quarterly Microscopical Journal.' As Professor Rogers, acting on this assumption, proceeds to explain that "an absolutely perfect screw cannot be taken as a standard, and hence this proposition of our friends abroad is hardly feasible" (for reasons which we must all readily recognize), it seemed desirable to make this correction.

It was also stated by Professor Rogers that he had a large collection of micrometers by different makers at home and abroad, including transfers from every well-known precision-screw in the United States; and although his investigations were not yet quite completed, he felt safe in saying that no two of them agree at a given temperature, the errors of subdivision being in many cases very large, and in all cases easily measurable.

Mr. Crisp further said that it was now four months since he brought before the Society the resolutions passed at the Indianapolis Congress of American Microscopists in August last, recommending the universal adoption of the $\frac{1}{100}$ of a millimetre as the unit of micrometry. As apart from the discussion that took place at the October and December meetings,* the subject had been thoroughly ventilated in the interim, there seemed no reason for postponing the subject further, and therefore with the view of bringing the matter to an issue one way or the other, he would give notice of moving the following resolution at the April meeting:—

"That in the opinion of this Society the most convenient unit for micrometric measurements would be the $\frac{1}{1000}$ of a millimetre."

He had purposely abstained from framing the resolution as in any way a recommendation which it might be considered they had no right to make, leaving it to express simply the opinion of the Society as to the most convenient unit.

In support of the first point embraced by the resolution, viz. the selection of a subdivision of the metre and not of the inch, it was hardly necessary to remind the meeting of the extent to which the millimetre was used at the present time in the scientific world; whilst as to the second point, the adoption of the $\frac{1}{1000}$ of a millimetre instead of the $\frac{1}{100}$, it would be borne in mind that the former, which was first suggested in Holland, was now the accepted Continental standard (under the name of micro-millimetre), with the special symbol μ (or sometimes Mik.), and was to be found in the works of both French and German writers (particularly diatomists), and in the Proceedings of the principal Continental learned Societies. Even without this to recommend it, he thought there could be little or no difference of opinion that $\frac{1}{100}$ of a millimetre was far too large a standard.

If it was considered desirable for any purpose not to lose sight of the inch altogether, the plan suggested by Mr. Beck of showing, on one micrometer, subdivisions both of an inch and of a millimetre, was a very convenient one.

Professor Keith's paper, "Note on Mr. Wenham's paper 'On the Measurement of the Angle of Aperture of Objectives,'" was taken as read in consequence of the lateness of the hour.

Mr. Tolles' paper on "An Illuminating Traverse Lens" was postponed until the next meeting.

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* See this Journal, vol. i. p. 310, and vol. ii. p. 108.

A Note by Mr. Crisp "On the Poison Apparatus and Anal Glands of Ants" (illustrated by two drawings) was taken as read for the same reason.

The President announced that after the conclusion of the ordinary meeting in April a special general meeting would be held to make two alterations in the Bye-laws. First, to provide that the composition fee payable by all Fellows hereafter elected should be 31*l.* 10*s.* instead of 21*l.*; and secondly, that the Presidents or Chairmen of the Biological or Microscopical sections of Societies coming under Bye-law 15 *b* might be elected Ex-officio Fellows in lieu of the Presidents of the Societies.

The following objects, &c., were exhibited:—

Mr. A. D. Michael:—Four slides illustrating his paper, viz.: (1) *Tegeocranus latus*, nymph (newly traced). (2) *Tegeocranus latus*, perfect creature. (3) *Tegeocranus labyrinthicus*, nov. sp. (4) *Scutovertex sculptus*, nov. sp.

Dr. and Mrs. Hoggan:—Twelve slides illustrating their paper, consisting of preparations from (1 & 2) the broad ligament of the uterus in a pregnant mouse; (3 & 4) from the mesentery of a rat; (5 & 6) from the mesentery of a guinea-pig; (6) from the skin of a leper (subcutaneous fat-layer); (7) from the mesentery of a nursing mouse; (8 & 9) from the mesentery of a mouse found nearly dead of starvation in an empty jar; (10) from the mesentery of a rat; (11) from the mesentery of a young rat weaned a week previously by its mother, which had brought it into a semi-starved condition, from which it had recovered; and (12) from the broad ligament of the liver of a rat. All illustrating different stages of development and retrogression of the fat-cell.

[Preparations were variously treated:—(1), (3), (7), (8), (11), and (12), silver and pyrogallate of iron; (2), (4), and (10), silver, osmic acid, and logwood; (5) silver and logwood; (6) blood-vessels injected first with silver, then with carmine gelatine, and section afterwards treated with osmic acid, picro-carminate of ammonia, and indigo; (9) silver, picro-carminate of ammonia, and osmic acid.

Mounted (5) in varnish, the others in glycerin.]

Mr. Beck:—New binocular Microscope with swinging bar for condenser, mirror, and lamp, and with improved movements.

Mr. Parker:—Five slides illustrating his paper, viz.: (1) *Scyllarus*, newly hatched Phyllosoma larva. (2) *Daphnia*, entire and dissected, showing structure of heart. (3) *Asellus*, mouth parts and abdominal appendages. (4) *Blatta*, salivary gland and Malphigian tubules. (5) *Chara*, longitudinal sections of terminal bud.

Mr. J. Mayall:—Tolles' illuminating traverse lens.

Mr. Stephenson:—New $\frac{1}{18}$ objective (by Zeiss) on the homogeneous immersion system (shown on Podura).

Mr. Crisp:—(1) A similar objective. (2) Dr. Seiler's mechanical microtome. (3) Two forms of mounting a hemispherical lens for immersion illumination (by Messrs. Ross), one enabling the lens to be

approximated more or less to the slide. (3) The Weber slide (see p. 55). (4) Small form of Dr. Woodward's prism (see vol. i. p. 246). (5) Stephenson's erecting binocular, with improved method of substituting the polarizing plane for the silvered reflector by the rotation of a screw, also with removable body for ready conversion into a monocular, rotating binocular body for the use of two observers, mirror with special movements, &c. (6) The first parabolic illuminator made by Mr. Wenham (in 1856.) (7) Slide of crystallized gold (see p. 193), (lent by Messrs. Beck).

New Fellows.—The following were elected Fellows of the Society:—The Right Hon. Lord Justice Bramwell, Messrs. A. M. Bremner, T. M. Harvey, T. W. Knight, P. Pochin, G. D. Sawyer, and R. Woodall. *Honorary Fellows.*—Professors P. Harting, of Utrecht; T. Schwann, of Liége; and Hamilton L. Smith, of Geneva, N.Y., U.S.

WALTER W. REEVES,
Assist.-Secretary.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

MAY, 1879.

TRANSACTIONS OF THE SOCIETY.

XII.—*A Contribution to the knowledge of British Oribatidæ.*

By A. D. Michael, F.R.M.S., with the assistance of C. F. George, M.R.C.S.E. (of Kirton Lindsey).

(*Read before the* Society, *March* 12*th*, 1879.)

Plates IX., X., and XI.

Amongst the *Acarina* are various groups which have received little attention in England, but, probably, there is not any family that has met with more neglect than the *Oribatidæ*, or beetle mites.

The common *Damæus geniculatus* is well known, and is mentioned by Curtis,* who discusses whether it is injurious to vegetation. I have seen a print, cut from some work published in 1800, inappropriately called the "Wandering mite," which is evidently one of the Oribatidæ, probably a *Notaspis*. Johnston † mentions a *Carabodes nitens* in Berwickshire, but I doubt it being possible to identify it, although it is evidently one of the Oribatidæ;

DESCRIPTION OF PLATES.

Plate IX.

Fig. 1.—*Tegeocranus latus*. Larva.

" 2.— " " Nymph full grown. The central ellipse on the back is the cast dorsal skin of the larva, the two next rings are the similar cast skins of the nymph in its earlier stages. *a*, stigmatic hair seen sideways; *b*, the other similar hair seen edgeways.

" 3.— " " Mature (perfect) creature × 65. *a*, wing-like expansions of the cephalothorax; *b*, stigmatic hairs; *c*, projection of the sternal plate cleft for the insertion of the first pair of legs; *d*, projecting lateral ridge (at a lower level than the dorsal plate), forming a protection to the first and second pairs of legs when they are folded up.

" 4.— " " Palpus (copied from Nicolet).

" 5.— " " Mandible " "

* 'Farm Insects.'

† 'Hist. Berwickshire Nat. Field Club,' vol. iii. p. 113.

some parts of his description must be errors, while other necessary particulars are omitted.

The occurrence of some Hoplophora has been noticed by Mr. George,* and there may be other flying notices. I am not aware that anyone has attempted to search out and put on record the species found in this country. The late Andrew Murray † simply notices one species in each of Nicolet's genera, remarking that many of them might probably be found here if properly looked for.

This neglect cannot arise from lack of objects of interest, as anyone paying attention to them will soon ascertain. I commenced collecting and investigating them last spring; while so engaged I accidentally ascertained that Mr. C. F. George, of

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PLATE X.

FIG. 1.—*Nothrus theleproctus.* Egg.
„ 2.— „ „ Larva.
„ 3.— „ „ Mature creature × 65. *a*, cast dorsal skin of larva; *b*, ditto of nymph (first change); *c*, ditto of ditto (second change); *d*, ditto of ditto (third change); *e*, back of perfect creature; *f*, stigmatic hair; *g*, stigmata.
„ 4.— „ „ Palpus × 300.
„ 5.— „ „ Mandible × 300.
„ 6.— „ „ Maxilla × 300.
„ 7.—*Tegeocranus elongatus.* *a*, hairs of the vertex; *b*, hairs proceeding from edge of wing-like expansion of cephalothorax and crossing in front of the rostrum.
„ 8.— „ „ Under side. *a*, labium; *b*, wing-like expansion of cephalothorax; *c*, shorter ditto lower in level; *d*, projection of sternal plate indented for insertion of first and second pairs of legs; *e*, anal plates; *f*, genital plates.
„ 9.— „ „ Palpus × 300.
„ 10.— „ „ Mandible × 300.

PLATE XI.

FIG. 1.—*Tegeocranus coriaceus* × 65.
„ 2.—*Tegeocranus labyrinthicus* × 65.
„ 3.— „ „ Mouth organs. *a*, labium; *b*, mandible partly showing from below the maxilla; *c*, maxilla; *d*, palpus.
„ 4.—*Scutovertex sculptus* × 65. *a*, tectum; *b*, wing of ditto; *c*, terminal hair of same wing; *d*, projecting point of dorsal plate; behind is seen the clearer depressed area arising from the absence or thinness of the chitine; *e*, stigmatic hair; *f*, projection from sternal plate between third and fourth pairs of legs.
„ 5.— „ „ Under side × 65. *a*, reflexed edge of the dorsal plate seen embracing the sternal plate.
„ 6.— „ „ Fourth and fifth joints and tarsus of first pair of legs, showing projection of fourth joint × 300.
„ 7.— „ „ Palpus × 300.
„ 8.— „ „ Mandible × 300.
„ 9.— „ „ End of a maxilla.

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* 'Science-Gossip,' 1877, p. 205.
† 'Economic Entomology.'

Kirton Lindsey, was doing the same thing. I communicated to him that I was preparing a paper on the subject to be submitted to this Society, and he at once placed his observations and specimens at my disposal, a piece of generosity which I desire most gratefully to acknowledge. I have endeavoured to mention his observations as they occur. My searches have been made during the past twelve months, near Tamworth, in Warwickshire; at Wandsworth, in Surrey; Epping Forest; and the shores of Loch Maree and Loch Ewe, in the Ross-shire Highlands; Epping being more thoroughly hunted than the other places.

Mr. George has collected entirely at Kirton Lindsey, in Lincolnshire.

I am aware that the 'Transactions' of this Society are not the place to monograph a family of British Arachnida, although of microscopic size, nor would the number of plates which can fairly accompany a paper like this enable one to do so, even if twelve months' searching were sufficient for the purpose, which is far from being the case; but I have thought that our observations might possibly be of sufficient interest, and would contain sufficient entirely new matter, to excuse my occupying a little of your time.

The plan I have followed is to give first a short summary of the principal distinctive characters of the family and a reference to the leading foreign bibliography (there is not any English); then such observations as to general matters as I have to submit; and, finally, to give a list of the species found, with any observations as to each species which I have thought new and interesting, and also details of such larvæ and nymphs, which had not been before observed, as I have been able to rear, so as to be certain what species they belonged to.

Distinctive Characters of the Family.

Taking for granted the distinctions common to all Acarina, the Oribatidæ are formed into a strongly marked group by the following characters, viz.:—

1. A hard chitinous exo-skeleton, as in a beetle; it is this resemblance that has given origin to the name of beetle mites. The chitine covers every external part of the perfect creature, and is very hard, but extremely brittle and entirely devoid of elasticity, so that on any pressure it breaks into fragments; it is always black or brown.

2. The form of the stigmatic and tracheal system, which is peculiar, consisting of two hard, more or less projecting, stigmata, of a short tubular or trumpet shape, one at each side of the cephalothorax near the juncture with the abdomen (but varying a little in position); below each of the stigmata is an air sac, and some long filiform tracheæ supplying the body, and from inside

the edge of each of the stigmata always proceeds a hair, the shape of which varies with the species; it is known as the protecting hair, and I have a few words to say about it hereafter.

3. The legs have invariably five joints, and are terminated by either one or three claws, without sucker or caroncle.

4. The palpi have five joints.

5. The ventral surface is pierced by three openings, the first formed anteriorly by the overhanging of the dorsal surface and posteriorly by a deep indentation of the sternal plate; through this opening the palpi and organs of the mouth are protruded (or withdrawn at will), and in most species the orifice can be almost entirely closed by the *labium*. The second orifice is rhomboidal or oval, and is always closed by two chitinous plates like folding doors, which open to afford a passage to the reproductive organs. The third orifice is the anal, and is similar in shape to the genital, and is closed by similar plates, which are usually larger than the genital ones.

6. There never are any visible eyes.

Bibliography.

I have not attempted to give an exhaustive bibliography, but only referred to the few authors whose works are of importance, and a reference to which is almost necessary for the latter part of this paper; these I have arranged, not in order of date, but, to some extent, in order of importance.

The first place must be assigned to Nicolet's monograph of the Oribatidæ in the neighbourhood of Paris,* an admirable work, beautifully illustrated, clear, and distinct. I have followed his arrangement, introducing such species as Nicolet did not find, in what appear to me to be their respective proper places; but, while doing so, I may say that I probably might not quite adhere to this system were I myself writing a monograph, as, although it has the advantage of great distinctness, it seems to me highly artificial, and I doubt if one or two of the distinctions can be supported, for instance, the great stress laid on the difference between homodactyl and heterodactyl claws; I doubt whether any truly homodactyl claws exist in the family, it seems to me probably more a question of degree.

C. L. Koch, in his great work,† has described and figured an immense number of species and given their classification in a subsequent work;‡ these two books form a vast storehouse of knowledge relative to the Acarina, and a monument of human industry; they are an absolute necessity to the apterologist, but it must be

* 'Archives du Museum,' 1855, t. 7.
† 'Deutschland's Crustaceen,' &c.
‡ 'Uebersicht des Arachnidensystems.'

confessed that the descriptions and figures are often scarcely sufficient for identification, and that every specimen which presents the smallest difference is given as a distinct species; often the male, female, and nymph, and even the nymph after each change of skin, are given as distinct species, producing confusion. Koch had scarcely a genius for classification; his genus *Nothrus* for instance is a strange collection of heterogeneous creatures. I should think it my fault that several of his genera do not convey any clear idea to my mind, if such men as Nicolet, Murray, and Mégnin, had not said the same thing before me.

Hermann * has described and figured several species in a manner, like all his work, most admirable, considering the date, but not always sufficient for modern requirements.

Dugès, † in his excellent papers on the Acarina, treats of the Oribatidæ, but more shortly than of the other families.

Ed. Claparède ‡ gives some highly interesting observations of the transformations of *Hoplophora*, &c.

There are numerous other authors, such as Gervais,§ De Geer, ‖ Latreille, ¶ Lucas, ** Thorell, †† &c., whose works contain valuable information.

General Observations.

It appears to be the result of modern research that the *Oribatidæ* are the only family of Acarina no species of which is ever parasitic at any stage of its existence; the various *Sarcoptidæ* and some others of the true *Acari* are always parasitic, the *Ixodidæ* partly so; the *Gamasinæ* and many of the *Hydrachnidæ* are parasitic during the nymph stage; the *Trombididæ* during the curious hypopial nymph stage; ‡‡ and Mégnin has lately shown that even some of the *Cheyleti* are in a sense parasitic, §§ but it never occurs amongst the *Oribatidæ*.

It seems to me that the numerous contrivances for protecting the legs in the *Oribatidæ* have not been sufficiently noticed, nor their purpose understood; the animals are all vegetable feeders, and are slow and cannot escape from enemies by running; they are not provided with weapons of defence, but are furnished with a very hard shell, and their safety consists in trusting to it and "shamming dead": this would be useless if their legs were exposed. Everyone who has seen a predatory mite seize a victim, knows that it usually

* 'Mémoire Aptérologique,' Strasbourg, 1804.
† 'Annales des Sciences Naturelles,' 1834.
‡ 'Studien über die Acariden,' Leipzig, 1868.
§ 'Histoire Nat. des Aptères,' Paris, 1847.
‖ 'Mémoires pour servir à l'Hist. Nat. des Insectes,' Stockholm, 1778.
¶ 'Hist. Nat. des Crustaces et des Insectes,' Paris, An XII.
** 'Exploration Scientifique de l'Algérie.'
†† 'Oefv. Sv. Ak.,' 28, 695. (1871.)
‡‡ Mégnin, 'Journal de l'Anatomie,' 1874.
§§ Ibid., 1878.

does so by the leg, and although a *cheyletus* might not be able to make much impression on one of the *Oribatidæ*, yet a *chelifer* would probably be more successful. This protection of the legs is carried to its highest perfection in *Hoplophora*, where the legs are short and project on the ventral surface near the hinder part of the cephalothorax, which is only united to the abdomen by an articulation allowing the former to shut down on the ventral surface of the latter, the hood which covers the cephalothorax forming a hard, close, box over the legs (which have been retracted), and the various parts of the mouth &c., so that (the genital and anal plates being closed) one unbroken, hard surface is presented to the enemy, and it is amusing to watch the cephalothorax being raised and the legs cautiously making their appearance when the danger is supposed to be over.

In the genera *Pelops* and *Oribata* there is a chitinous flexible wing-like expansion to the fore part of the edge of the abdomen, projecting a little forward; when any alarm occurs, the legs are neatly folded against the body and this wing-like cover closed over them, making the whole as snug and as slippery as possible.

In the genera *Tegeocranus*, *Notaspis*, &c., the sternal plate or the lower edge of the dorsal bears several strong projecting ridges, leaving deep depressions between them into which the legs, when folded up, exactly fit; the leg generally being bent at the middle joint, and one ridge lying within the flexure, so that the whole leg can lie upon the under surface of the body, and be almost as well protected as by the former methods.

In *Eremæus*, &c., the coxæ of the first and second pairs of legs are set in deep indentations of the sternal plate open above and below with strong projections between. I have observed that this arrangement not only protects the leg, but also enables the creature to raise it right over its back, which is useful to it, enabling it to right itself when it falls on its back, as it frequently does.

While treating of the modes in which *Oribatidæ* protect themselves, I may call attention to the singular habit which several species, and the nymphs of others, have, of coating themselves with extraneous matter; this is attained in various ways. In most members of the genus *Nothrus* the back is concave, and dirt is piled in the concavity; in *Damæus geniculatus* and *D. clavipes*, the back, particularly in the nymphs, is provided with numerous long hairs; it is by some means plastered with mud, which adheres to the hairs, and indeed, it is not easy to get it off without destroying the creature. In *Damæus papillipes* and *D. verticillipes* a different mode is seen; the whole creature, including legs, and often each individual hair, is thickly coated with white dust, so that the animal looks as if it had been rolled in plaster of Paris.

Another strange habit of many of the *Oribatidæ*, which also is probably protective, consists in carrying on the back a pile, or

shield, of the dorsal parts of the cast skins from the earlier stages, which, adhering closely to the back of the perfect creature, or the nymphs, as the case may be, give it the appearance of being a totally different shape from what it is; this is seen in *Damæus verticillipes*, *Nothrus theleproctus*, and others, and is admirably shown in the nymph of *Tegeocranus latus*.

Before closing these general observations, I should mention habitat: *Damæus geniculatus* and *D. clavipes*, the genus *Hoplophora*, and some others, live chiefly under bark, and more especially in decaying wood; some of the genus *Oribata* may be found on the leaves of trees, but the greater number of the *Oribatidæ* are more or less solitary, and live either in moss, preferring that growing on the lower parts of trees, or under stones, but I have found them most numerous upon some of the parasitic fungi which grow out from the stems of trees in woods; this is specially the case with *Tegeocranus*. The moss must be damp but not wet; I have found but few when it was either very wet or very dry.

Transformations.

I consider that the most interesting work that I have done for this paper in this department is in tracing the transformations and life-history of *Tegeocranus latus*, the larva and nymph of which have not, to my knowledge, been before observed, and are remarkable creatures; indeed, I fancy that those who look at the nymph and perfect creature will agree with me that no more singular transformation exists amongst the *Acarina*.

The mode of watching transformations which I have adopted has been much the same as I employed in breeding *Cheyleti* and *Glyciphagi*; I have succeeded better with a simple glass ring cell with a loose thin cover kept on by a clip, than with more elaborate or more perfect apparatus; into each cell a small piece of moss or decayed wood was placed, having been first carefully examined under the Microscope to see that it did not contain mites or *ova*, then the mites to be studied were carefully picked in one by one, only one sort being placed in a cell, and only a few specimens; each cell was examined every day, and air and moisture given when necessary. When I was fortunate enough to find a captive commencing its transformation, the whole apparatus was transferred to the stage of the Microscope and the change watched; I have usually kept some twenty-five to thirty of these breeding cages going through the past summer, but have found great difficulty in keeping some species, and have not succeeded in getting them to lay eggs, although I have bred through from eggs and larvæ which I have found.*

The escape of the larva from the egg I have watched in the

* Since this paper has been lodged with the Society I have succeeded in the case of *Tegeocranus coriaceus*.

case of *Damæus geniculatus* and *D. clavipes;* the egg in these species is an oval somewhat flattened on two sides; it is brown, but round the edge runs a lighter band where it seems that the shell is thinner; along this band the shell breaks, finally separating into two boat-like pieces; it breaks first at the small end, which contains the head, or rather rostrum, of the larva; the long legs are doubly folded upon the under side of the body; the long hairs of the back lie flat and pointing straight backwards; the front part of the cephalothorax, when I watched the process, protruded first; it was slowly followed by the anterior pair of legs; then the whole cephalothorax and the second pair of legs gradually made their appearance, the progress being very slow; a long delay then seemed to take place, during which the various parts stiffened and assumed their normal positions, the hairs becoming more or less perpendicular; the hinder pair of legs (for the larva is hexapod) remained in the shell until the last, and pushing against the inside of one half, while the back rested in the other, seemed slowly to open it. As the different parts emerged, everything movable was kept continually moving, a strange sight in these slow and lazy creatures; the legs were worked in all directions, and it was amusing to watch the parts of the mouth constantly going; the lobster-like mandibles, usually so difficult to see, were protruded and retracted independently, and kept snapping continually. The escape from the egg lasted six or eight hours; I cannot say if it takes as long in a state of nature.

The change from the larval to the nymph stage does not offer any sufficient difference from that from nymph to perfect creature to make it necessary to describe it. Claparède (*loc. cit.*) in his admirable papers on the Acarina describes how he watched the transformations of water mites of the genus Atax, and found that, on the change from larva to nymph and from nymph to perfect creature, it was not a mere change of skin that was effected, but that the whole creature dissolved, the new creature being formed from the material, the skin of the old creature coming away and leaving an egg-shaped body, long before the new creature was fully developed. More lately Mégnin has traced the development of the *Sarcoptidæ* and *Gamasinæ* with precisely the same result as Claparède.

I am not aware that anyone has previously watched the *Oribatidæ*, but my own observations upon them certainly lead me to the same conclusion. It must not, however, be forgotten that Dugès, in his excellent chapter on the *Hydrachnidæ*, the transformations of which he watched, expresses a contrary opinion, and says that the creature retires within its own skin as within a bag, and that the parts are modified rather than newly formed; and he says, in support of this view, that mutilated parts do not reappear. Probably the real divergence of opinion is not so great as it seems,

as Dugès describes a partial dissolution, although he thinks that the legs, for instance, are formed at the expense of the old legs instead of from the general mass of the body, which Mégnin denies, and which does not coincide with my own opinion.

As a rule, the integument of the larva and nymph of the *Oribatidæ* is soft and light-coloured; in the perfect creature it is hard and dark; this is subject to the modification hereafter mentioned.

In the final change, which I have carefully watched in the case of *Tegeocranus latus* and *Oribata punctata*, the adult nymph gradually becomes inert, creeps into a hole or sheltered place, and seems to me to fix its claws firmly in whatever it is resting on; it then becomes motionless and to all appearance dead. In one or two instances with *Tegeocranus latus* I carefully cut out the minute piece it was fixed on, and placed it where I could see it better, preserving the same conditions; in this state it remained for about a fortnight without any signs of life, at the end of that time the skin got rapidly darker, and about twelve hours after, the skin split at the posterior edge (the creature being a flat oval) and the anal margin of the body of the adult slowly appeared by the skin shrinking from it; this splitting along the edge and shrinking of the skin imperceptibly proceeded from behind forward, the creature remaining motionless. After five or six hours one could see that the parts of the perfect creature were formed independently of the similar parts of the nymph, the legs, for instance, not being formed within the old legs which were stretched out, but being folded on the body and securely packed within the depressions between the protecting ridges before mentioned. When the skin had split sufficiently far, the perfect creature at last moved, slowly unfolded its legs, withdrew its cephalothorax from the fore part of the old skin, like a finger from a glove, and walked off, leaving the old skin with outstretched legs in the same position it had occupied for a fortnight.

With regard to the discovery of the nymph of *Tegeocranus latus*, one day, when searching for *Oribatidæ* amongst moss on an old tree stump in Epping Forest, I found between the moss and the wood a creature new to me. On examining it under the Microscope, I found that it belonged to the family I wanted, but was so strange and *bizarre* that I hardly knew how to class it; it was a flat oval, the edge cut into great triple serrations difficult to describe, and from each serration sprang a long thick spine, bent into an elegant double curve and armed with short thorns, while ring within ring on the back were the cast dorsal skins of the earlier stages, each bearing its own serrations and spines, so that the whole dorsal surface was a *chevaux-de-frise*, the ventral surface being pressed close to the wood. At once there arose the question, was this

strange organism a nymph or a perfect form? As before stated, the nymphs are usually soft and light-coloured, the perfect form hard and dark, but this is modified by the fact that with each change of skin the nymph becomes somewhat harder and darker, so that the nymph of a species, the adult of which is very black and hard, as in the *Tegeocrani*, becomes, before the final change, as dark and hard as some other species, e.g. many of the genera *Nothrus* and *Eremæus*, are after it. To decide this I searched and at last obtained several more living specimens of various ages; some appeared to show eggs, which strongly favoured the idea that it was an adult, as the appearance somewhat indicated. I also obtained some cast skins. While in doubt, I received a letter from Mr. George, with a rough sketch of something he had found, which was manifestly my creature; he had only one specimen, and, like myself, was in doubt whether it was a nymph or adult; his individual showed eggs, which pointed to the adult theory. I kept all I could get alive for some weeks without any indication of a more perfect stage; still I could not rid myself of the idea that it was only a nymph, my reasons being, first, that it bore on its back the dorsal parts of the larval and two pupal skins only, and in *Nothrus theleproctus* and others that I had watched, the nymph had cast its skin twice *before* the change to the perfect form; secondly, that I found what seemed to be a discarded skin as perfect as the animal I had alive; if it were, something must have come out of it; thirdly, I had one dead specimen which seemed to show something forming below the skin. I kept my breeding cages going until the last day of my stay in Epping Forest, without success; but the evening before I left, one became much darker, and the morning I was leaving for the Highlands the skin of the nymph split, and *Tegeocranus latus* emerged as before described.

I relate this to show the necessity for caution in judging whether a newly found mite is a nymph or perfect creature, and how excusable it was in Koch to figure them often as separate species, writing when he did.

I have mentioned above that some specimens apparently contain eggs; it is quite possible that Mr. George and I were mistaken, and that they were not eggs; their being so seems inconsistent with the dissolution and reformation of the animal in the change from nymph to imago; but it must be remembered that C. Robin has shown * that the male *Dermaleichi* copulate, not with the final form of female, but with an intermediate form, which in appearance almost exactly resembles the nymph; and the same author and Mégnin have demonstrated that this intermediate form, which they call "*femelle accouplée*," often shows eggs, although not provided with any vulva of gestation, which only appears in the final form of female. This

* 'Comptes Rendus,' 1868, p. 776.

is asserted by Mégnin to apply to the *Tyroglyphi*, *Glyciphagi*, *Carpoglyphi*, *Gamasinæ*, and *Trombididæ*: it would therefore from analogy be likely to occur in the *Oribatidæ*, although I am not aware that it has been observed, and if so these may well have been *femelles accouplées*, or, as I should call them, nubile females.

I was curious to see how the casting of the skin was so managed as to leave the pile of the dorsal parts on the back, and thought this a favourable species to observe. I did not find any difficulty in doing so. The skin splits along the edge, commencing at the rear as before described, until it reaches the rear of the vertex; then the split, instead of continuing round the edge of the cephalothorax, goes across the back, and the creature backs out of the fore and lower part of the old skin, keeping the dorsal, or rather dorso-abdominal, portion still on its back. There does not appear to me to be any disintegration of the creature in mere changes of skin. Every larva or nymph which I have figured or mentioned I have assured myself of by breeding it to the perfect form.

Organs of Special Sense.

As before stated, *Oribatidæ* have not any visible eyes that have yet been discovered. I have before expressed an opinion that others of the Acarina whose condition is similar have some sense of sight, or are, at all events, sensitive to light, which most of them dislike; in order to utilize this dislike in tracing sight further if possible, I placed a living *Eremæus oblongus*, one of the most lively of the *Oribatidæ*, in a large glass cell, putting a piece of moss in the middle. I then arranged the Microscope so that the sun fell on the stage, but placed a dark screen to throw it into shadow. I then placed the cell on the stage, and watched until the mite was on the raised edge of the cell, where they generally like to be. I then suddenly removed the screen; the mite did not wander vaguely about, but came down from the edge, and crossed the bottom of the cell in a straight line for the moss, under which he got; the same experiment repeated once or twice had the same result. I leave my hearers to decide whether this does not indicate some sense of sight.

What are called the protecting hairs of the stigmata were once supposed to be organs of vision; this was evidently incorrect, and is long since exploded. The high authority of Nicolet and others is in favour of their being simply protecting hairs. Doubtless the contrivances by which stigmata and spiracles are protected are various, but it is generally apparent that they are admirably suited to their purpose. It is not, however, at all clear how these hairs can be of any protection; there is never more than one on each side; they cannot exclude dust, &c., because whatever the form of the hair, only the fine part is near the stigmatic opening, and they are too

soft and flexible to be effective defensive weapons; whereas the joints of the legs are often defended by powerful spikes; the clubbed ends borne by so many of these hairs are often hollow or cellular, and it seems possible that they may be eventually found to be the seats of some special sense (as hearing or smell) instead of being merely protective.

Summary.

The results of the season's work may be summarized thus: forty-four species have been found, of which I believe that only three or four have been previously recorded in Britain. The total number which rewarded Nicolet's admirable and prolonged search in France was fifty-six.

Of these forty-four species, I believe three to be entirely new to science, viz. Nos. 21, 38, 39.

Two species have, to my knowledge, been found in France, Germany, and Sweden, viz. Nos. 2 and 32.

Eighteen species in France and Germany, viz. Nos. 3, 5, 13, 15, 17, 22, 24, 25, 26, 27, 29, 31, 32, 33, 36, 40, 43, 44.

Fourteen species in France only, viz. Nos. 1, 4, 6, 8, 10, 11, 12, 14, 16, 18, 23, 28, 41, 42.

Six species in Germany only, viz. Nos. 9, 19, 20, 34, 35, 37. I include Switzerland with Germany for this purpose.

One species in France and Algeria, viz. No. 7; probably they would have been found elsewhere if properly looked for, as two or three have also been found in Spitzbergen.

The life-history of two sorts, *Tegeocranus latus* and *Nothrus theleproctus*, has been traced for the first time, and others confirmed, in addition to the above observations on habits, &c.

Part II.

In this part the following rules have been observed:—

Species which have been described by Nicolet are not redescribed, but those given by Koch or others are described where the description of the author referred to does not seem to me sufficient for certain identification. Species believed to be new are described.

If there be fair grounds for believing that a species found by me is identical with, or a slight variety of, one known by me to have been already described, that species is adopted (defining it) instead of giving a new name, although the former description may not be sufficient for actual certainty.

With regard to naming the joints of the legs, *Robin* is followed, not *Nicolet*; this I have done, regarding Robin as the more eminent anatomist as well as the more modern authority. It must be remembered that their views are entirely different, e.g. the *trochanter* of

Robin is the *femoral* of Nicolet; in other respects, Nicolet's names for parts of the exo-skeleton are preserved.

The sexes are not described separately, their external differences being usually so slight that it is unnecessary.

All measurements are in decimals of a millimetre.

A reference to Koch without naming the work means his 'Deutschland's Crustaceen Miriapoden und Arachniden,' Regensburg, 1841.

In the Plates, all whole creatures are drawn × 65, most details are × 300.

All the figures are drawn from nature, except Figures 4 and 5, Plate IX.

All whole creatures were drawn in the first instance with the camera.

GENUS PELOPS.

1. Pelops farinosus. Nic.

Nic. 425.

Found at Kirton Lindsey by Mr. George, and by me at Epping Forest and Loch Maree; not uncommon.

The English specimens have not the round spot in the centre of the abdomen figured by Nicolet, nor the two spatulate hairs one on each side of it, and the stigmata are not as deeply sunk as in Nicolet's drawing. It might be said these differences are sufficient to constitute a species, but in the absence of further evidence, I prefer considering them as showing a variety only.

GENUS ORIBATA.

2. Oribata alata. Herm.

Notaspis alatus. Hermann, 'Mémoire Aptérologique.'
„ „ Dugès, 3rd Mémoire, 47.
Acarus coleoptratus. Linnæus, 2nd edn. No., 1973.
Zetes dorsalis. Koch, fasc. 2, pl. 14.
Oribata alata. Gervais, 'Histoire Nat. des Aptères,' vol. iii. 258.
„ „ Nicolet, 'Hist. Nat. des Acariens,' &c., 431.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest.

3. Oribata Lucasii. Nic.

Nic. 432.

Zetes lævigatus. Koch, fasc. 3, pl. 8.

Found at Epping Forest.

4. Oribata nitens. Nic.

Nic. 433.

Found at Epping Forest.

5. Oribata punctata. Nic.

Oribates ovalis. Koch, fasc. 3, pl. 5.
Oribata punctata. Nic. 434.

Nymph and perfect creature found everywhere; common. I have bred this creature through its changes, and can confirm the correctness of Nicolet's figure of the nymph.

I use Nicolet's name of *punctata* instead of Koch's earlier name of *ovalis*, because the latter author gives an *Oribates ovalis* and an *Oribates ovatus*, which might cause confusion.

6. Oribata piriformis. Nic.

Nic. 436.

Found at Epping Forest and Loch Maree; scarce.

In the English specimens the stigmatic hairs are more strongly and suddenly clubbed than in Nicolet's figure.

7. Oribata lapidaria. Lucas.

Lucas, 'Exploration scientifique de l'Algérie,' 318.

Nic. 439.

Found on trees everywhere; very common.

I think it possible that this and *Oribata globula*, Nic., may turn out to be one species; certainly some of what I have found are forms intermediate between the two types.

8. Oribata Edwardsii. Nic.

Nic. 438.

Found at Loch Maree.

9. Oribata mollicomus. Koch.

Oribates mollicomus. Koch, fasc. 30, pl. 20.
Oribata notata. Thörell, 'Oefvers. af Kongl. Vet.-Akad.' 1871, 695.

I have found three or four specimens of what appears to be this creature at Epping Forest. It is quite possible that it is not truly a species, but only another variety of *Oribates setosus* (Koch, fasc. 30, pl. 19; Nic. 436); in which case it is better that the latter name should stand as Nicolet has adopted it; but the reasons against this are, Firstly, in my specimens the wings of the tectum are not joined by any transverse ridge—a distinction by no means unimportant, as Nicolet relies greatly on this ridge; Secondly, my specimens are much smaller than Nicolet's; Thirdly, the rows of hairs on the back are much wider apart from row to row, and contain fewer hairs than in Nicolet's figure; Fourthly, the coxæ and tro-

chanters of the first two pairs of legs in my specimens are prolonged at the edge into thin flat blades not mentioned by Nicolet.

I think this is probably the species recorded by Thörell as found at Bell's Sound, Spitzbergen.

10. Oribata globula. Nic.

Nic. 439.

One specimen found at Epping Forest.

GENUS LEIOSOMA.

11. Leiosoma nitens. Gervais.

Oribata nitens. Gervais, in Walckenaer, vol. iii. p. 259.
Leiosoma nitens. Nic. 441.

Found by Mr. George at Kirton Lindsey.

12. Leiosoma similis. Nic.

Nic. 442.

Everywhere; common.

In English specimens the central point of the tectum is not as sharp as in Nicolet's figure, but is more square.

13. Leiosoma ovata. Koch.

Leiosoma lativentris. Nic. 443.
Oribates ovatus. Koch, fasc. 30, pl. 24.

Found at Epping Forest and Loch Maree.

The English specimens seem much smaller than the size given by Nicolet (·55 mm. instead of ·75 mm.), but as they agree in all other respects I do not think this sufficient to found a species.

14. Leiosoma microcephala. Nic.

Nic. 443.

Found at Epping Forest; scarce.

GENUS CEPHEUS.

15. Cepheus tegeocranus. Herm. 93.

Notaspis tegeocranus. Gervais, in Walck. iii. 258.
Cepheus vulgaris. Nic. 445.

Found everywhere; common.

In the English specimens the rows of hairs on the abdomen are not nearly so conspicuous as they are in Nicolet's plate.

16. Cepheus latus. Nic.

Nic. 446.

Found at Epping Forest.

The English specimens have small hairs on the abdomen, not figured by Nicolet, and the anterior line of the abdomen is very slightly sinuated. I cannot help doubting whether the species is really more than a variety of *C. tegeocranus*.

GENUS NOTASPIS.

17.' Notaspis bipilis. Herm.

Hermann, 95.

Nic. 448.

Oribates badius? Koch, fasc. 30, pl. 23.
Oppia cornuta. „ „ 38, pl. 8.
Oribata bipilis. Gervais, vol. iii. p. 259.

Found everywhere; common.

18. Notaspis exilis. Nic.

Nic. 448.

Found everywhere; common.

The small hairs on the abdomen figured by Nicolet are absent, or very inconspicuous, in the English specimen.

Is Nicolet's *N. tibialis* really a distinct species?

19. Notaspis pilosus. Koch.

Zetes pilosus. Koch, fasc. 31, pl. 12.
„ *pilosulus.* „ Uebersicht, 101.

Average length about ·45 mm.
„ breadth „ ·3 mm.

Found at Epping Forest; scarce.

This and the next species clearly should not have been included in Koch's genus *Zetes*, which Nicolet has properly joined to *Oribata*. I have had great doubt if they are really distinct, but on the whole I think that the difference in the so-called stigmatic hairs, which are good specific distinctions in the *Oribatidæ*, the smaller size and rounder shape of the body, and the far greater development of the general dorsal hairs in this species, are sufficient to justify both being retained, subject to future investigation; this one, at all events, should stand.

Colour red-brown, sometimes almost red. *Cephalothorax* conical, with a constriction a short distance from the front, thence it curves outwards until about the middle, whence the central portion runs nearly straight back rising to the level of the abdomen; the lateral

portions are much lower in level, and expand into a shelf with deepish indentations for the insertion of first pair of legs and shallower ones for the second pair. *Tectum* so entirely amalgamated with *cephalothorax* that it is only shown by two strong spinose bristles standing up at its termination; two similar bristles stand up straight behind the first pair, just at the hind margin of the vertex, two shorter similar ones horizontal at the above-named constrictions; stigmata at the edge of the raised part of cephalothorax almost under the edge of the abdomen; the stigmatic hairs medium length, standing upwards and slightly outwards, filiform, about half the length, thence spatulate with blunt-pointed tips. Mandibles large and projecting.

Abdomen a short pear-shape, hinder end very round, anterior end narrow, with a rounded point projecting on to cephalothorax and joined to it on a level; a strong spike stands straight out horizontally from each edge of the dorsal plate between the second and third pairs of legs. A row of about seven very long hairs (nearly half as long as the abdomen) curved backwards round edge of each side of abdomen; six similar round hind margin lower in level, and three pairs down back more central; coxæ of first two pairs of legs hidden, those of two hind pairs conspicuous; all trochanters stout, claws large.

20. Notaspis lucorum. Koch.

Zetes lucorum. Koch, fasc. 31, pl. 18.

Average length about ·67 mm., but variable breadth about ·37 mm.

A creature which I believe, not without doubt, to be Koch's *lucorum*, has been found by Mr. George at Kirton Lindsey, and by me at Epping and Loch Maree; it had, however, been previously found by Mr. Underhill, of Oxford, and figured by him in the 'Notes of the Postal Microscopic Club,' December 19th, 1877. It is a very variable species, the abdomen in some specimens being considerably longer in shape than in others. The distinctions from the last species are, its larger size and more pointed abdomen, the stigmatic hairs being much shorter, and instead of being spatulate having a short filiform stalk terminated by a piriform club, so short as usually to appear a ball which hardly rises above the back, and that the dorsal hairs are much shorter.

Genus Scutovertex.* Mihi.

This genus I have, somewhat unwillingly, originated, for a creature which has not, to my knowledge, been recorded before, and which, although bearing many resemblances to *Eremæus*, is so opposed to some of the main characteristics by which Nicolet defines

* *Scutum*, a shield, and *vertex*, the top of the head.

that genus, that it appears to me that it cannot properly be included therein.

Generic Characters.

Palpi with first joint small, second and third swollen, the second being considerably the longest; fourth and fifth joints much slighter, but fifth as long as second, and dentated on the outer edge. *Labium* broader than long, nearly straight on the anterior edge, and not covering above half the buccal opening. *Mandibles* rather long with the fixed claw not toothed. *Maxillæ* bilobed, lobes unequal. *Cephalothorax* large and conical, *having a tectum attached only by its base,* less wide than the cephalothorax, and covering part only of its length. Cephalothorax deeply indented for the reception of the coxæ of the first pair of legs, which are almost entirely hidden, those of the second pair being supported by strong projections. Legs thick and shorter than the body; all the trochanters and the coxæ of the last two pairs broad and flattened; fourth joints of the first pair of legs with a projection overhanging the fifth like *Eremæus.* Tarsi with three heterodactyle claws, the centre one being conspicuously the thickest. Abdomen longer than broad, flattened on the dorsal surface, the dorsal plate of which projects anteriorly over the cephalothorax, and may be fastened to the upper surface of the tectum, and also projects at the anterior angles (or shoulders) sheltering the stigmata, which are wide apart, set far back, and point outwards.

This genus will fall in Nicolet's first division, being tridactyle; in the first subdivision, being furnished with a tectum, and it would appear to come properly at the end of that division immediately before *Eremæus,* which latter genus it resembles in the form of the tarsi and claws, the mode of insertion of the legs, and many other particulars, while it is divided from it by the tectum, the form of the palpi and labium, the thickness of the legs, &c.

21. Scutovertex sculptus. Mihi (Plate XI. Fig. 4).

Average length about ·60 mm.
„ breadth „ ·33 „

New Species.

Colour varying from dark red brown to black.

Cephalothorax large at the base and bluntly conical, but mostly hidden under the advancing dorsal plate of the abdomen. *Tectum* almost square, but a little longer than wide; wings of tectum raised almost perpendicularly, broadest anteriorly, and ending in long, blunt, curved points, with curved terminal hairs. A little way in front of the tectum is a round plate covering the point of the rostrum, and raised in the centre and at the edge. From below this a ridge runs along the side of the cephalothorax, ending in a

rounded elevation before reaching the first pair of legs. These are set in deep clefts of the sternum, open above, and open, but to a less extent, below. Between the second and third pairs of legs, is a long, chitinous projection of the sternum, bifid at the end. Stigmatic hairs medium length, slightly spatulate at the ends, where they are roughened with small points; cephalothorax and tectum covered with evenly-scattered, rough, elevated spots; wings of tectum reticulated with small raised ridges; all joints of the legs, except the *tarsi*, thick, rather flattened, broadest anteriorly, and rough with sinuous ridges. No hairs on the *vertex*, two short ones at the point of the rostrum, one or two on each of the first four joints of each leg, and numerous ones on the tarsus. Dorsal plate of the abdomen a long oval, rounded posteriorly, with a waved edge prolonged anteriorly over part of the cephalothorax, and ending in a sharp point soldered to the tectum; edges of the plate slightly projecting in front, a narrow transverse ridge near the anterior point, from the ends of which ridge other ridges start, nearly at right-angles, and then curve out to the before-named projecting ridges: in the centre of the space between these ridges is a light-coloured depressed, oblong marking with rounded corners. This looks clear, and, when the dorsal plate is removed and looked at from the inside, it is seen to be due to the chitine being absent, or extremely thin, there seeming to be a membrane only. Dorsal plate thickly dotted round the edges, but with much larger elevated markings, having the appearance of rings by transmitted light, towards the centre; four small spatulate hairs at the anal margin, and two lines of four or five similar ones down the back. Whole under surface strongly spotted; anal plates large, raised, and pentagonal; vulval plates nearly square.

GENUS EREMÆUS.

22. Eremæus oblongus. Koch.

Koch, fasc. 3, pl. 24.

Nic. 451.

Found everywhere; common.

23. Eremæus Cymba. Nic.

Nic. 452.

Found at Epping Forest, and near Tamworth. Rare.

GENUS NOTHRUS.

24. Nothrus spiniger. Koch.

Koch, fasc. 2, pl. 18,

Nic. 455.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest.

25. Nothrus horridus. Herm.

Notaspis horridus. Herm. 90.
Oribata horrida. Gervais, iii. 254.
Nothrus horridus. Nic. 456.
Nothrus runcinatus. Koch, fasc. 29, pl. 23 } nymph in different
" *sinuatus* " " " " 22 } stages.
" *mutilus* " " " " 18 ?

Found everywhere.

It seems quite possible that Thörell's *Nothrus borealis* may turn out to be a northern variety of this species.

26. Nothrus bicarinatus. Koch.

Koch, fasc. 29, pl. 16.
Nic. 456.
Nothrus furcatus. Koch, fasc. 30, pl. 3 } nymph.
" *segnis.* Hermann, 94 }

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest and Loch Maree.

27. Nothrus palustris. Koch.

Koch, fasc. 29, pl. 13.
Nic. 457.
Nothrus palliatus. Koch, fasc. 29, pl. 31 } nymph.
" *bistriatus* " " 30 " 4 }

Nymph found by Mr. George at Kirton Lindsey and by me at Epping Forest and Loch Maree: perfect creature found at Loch Maree.

28. Nothrus nanus. Nic.

Nic. 458.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest.

29. Nothrus theleproctus. Herm. Pl. X. Fig. 3.

Notaspis theleproctus. Herm. 91. }
Liodes theleproctus. Heyden. } carrying cast skins.
Nothrus theleproctus. Koch, fasc. 29, pl. 10 }
" *convexus* " " " " 1, without cast skin.
" *farinosus* " " " " 8, carrying one cast skin only.
" *canaliculatus* " " " " 7, washed clean ?

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest and near Tamworth.

Koch's and Hermann's descriptions may serve without repetition, as the species is very distinct. It usually carries the cast

dorsal skins flat on the abdomen concentrically, hence the concentric horseshoe-shaped lines figured by those authors. The point at the anal end of the abdomen is formed only by a projection of thin chitine, and may break away without injury to the creature; it seems to me that Koch's *canaliculatus*, which is founded on a single specimen fished out of water, may have been *theleproctus* washed clean, and with the cast dorsal skins and anal projection gone. The description, however, is not sufficient to make sure of this.

The constriction in the cephalothorax in Hermann's figure is far too deep.

The larva of this species, which I have bred, is very light brown; cephalothorax short and broad; stigmata very open, pointing upwards, and with a serrated margin; stigmatic hairs short and spatulate; abdomen much and irregularly wrinkled, straight anteriorly, broadest in the middle, thence drawn out to a blunt point, with two spatulate hairs; anus long, and about central in the abdomen; being usually far forward; legs very short and stout, with spatulate hairs (see Plate X., Fig. 2).

The nymph is almost similar to the perfect creature, but of course with a smaller number of cast dorsal skins.

GENUS DAMÆUS.

30. Damæus geniculatus. Linn.

Acarus geniculatus. Linn. vol. ii. 1025.
Koch, fasc. 3, pl. 13.
Nic. 460.

Damæus torvus. Koch, fasc. 3, pl. 14. Nymph.
Notaspis clavipes. Dugès.

Found everywhere; very common under bark of dead trees, in dead wood, &c.

Great confusion has existed between this species and *clavipes.*

31. Damæus riparius. Nic.

Nic. 461.

I found two specimens at Loch Maree of what I think must be this species, although they are rather smaller than the size given by Nicolet, and the sinuated anterior margin to the abdomen mentioned by him is hardly, if at all, shown; in all other respects they agree. I think it better to disregard these differences, although Nicolet relies on the sinuated margin, than to call these specimens a new species; the difference may arise from locality.

32. Damæus clavipes. Herm.

Acarus geniculatus.	Linn. vol. ii. 1025.
Oribata geniculata.	Fabricius, 'Ento. Sys.' vol. iv. 431.
" "	Latreille, 'Gen. Crust. et Ins.' 149.
" "	Schrank, vol. iii. 208.
Notaspis clavipes.	Herm. 88.
Damæus geniculatus.	Koch, fasc. 3, pl. 13.
Acarus corticalis.	De Geer, vol. vii. 131.
Damæus auritus.	Nic. 463.
" "	Murray, 216.

Found at Epping Forest; not common, although Nicolet says it is in France.

I have not followed Nicolet's name, although adopted by Murray, as I fail to see why he took the name which Koch had given to the species Nicolet calls *riparius*, or why Hermann's far older name of *clavipes* should be discarded; no doubt the earlier writers did not distinguish between this species and *geniculatus*, and included both under one description, but Hermann's figure is certainly this species and Nicolet says that it is.

33. Damæus verticillipes. Nic.

Nic. 462.

Damæus nodipes.	Koch, fasc. 30, pl. 6.
" *onustus.*	" " 38, " 7, with coating of dirt and cast skins.

Found at Epping Forest and Loch Maree.

Most of the specimens of this creature which I have found have been thickly covered with fine white dust, like *pulverulentus* (Koch); this is not mentioned by Nicolet.

Damæus nitens. Koch.

34. *Oppia nitens.* Koch, fasc. 3, pl. 10.

Average length about ·48 mm.
" breadth " ·32 "

I have a specimen or two found in cellars at Mortlake, Surrey, and at Tamworth, which strongly resemble Koch's *Oppia nitens*, but it is difficult to say for certain, as his description is so slight; but rather than make a new species I adopt his.

Colour brown; cephalothorax about half the length of the abdomen, conical about two-thirds of its length (from the front) then widening sharply to a slight shoulder, which is indented for the insertion of the first pair of legs, but forms an irregular projection extending from these to the insertion of the second pair; stigmatic tubes more widely separated and less raised than usual in

genus. A long hair standing upright midway between each stigmatic tube and the central line, two further forward, and two short curved ones at the point of the rostrum. Abdomen oval, slightly pointed posteriorly, very polished, two rows of long light hairs round margin, two separate ones in the centre of the back (transversely), near the anus, and four shorter round the anal margin; coxæ of first two pairs of legs concealed from above, those of two posterior pairs conspicuous; legs with the femoral joints very short and cylindrical, other joints as in *geniculatus;* a few light hairs on each joint.

Damæus splendens. Koch.

35. *Oppia splendens.* Koch, fasc. 32, pl. 6.

Average length about ·31 mm.
" breadth " ·14 "

I am not able to see any sufficient distinction between the genera *Damæus* and *Oppia*, and therefore I have not adopted the latter.

Found at Wandsworth, Epping Forest, and near Tamworth.

This is the smallest member of the *Oribatidæ* I have found; why Koch called such a minute, unobtrusive creature *splendens* I cannot explain, unless it were a kind of grim joke: his descriptions and figure, however, leave little doubt as to identification; indeed, the very small size and the singular way in which the joints of the legs are enlarged nearly into balls, making the legs under a low power look like a string of beads loosely strung, distinguish it at once. This is conspicuous and exceptional at the insertion of the tarsi in the first two pairs of legs. Stigmatic hairs rather long, with a flat, fusiform, pointed club.

GENUS TEGEOCRANUS.

36. Tegeocranus latus. Koch. Pl. IX. Figs 1, 2, and 3.

Cepheus latus. Koch, fasc. 3, pl. 11.
Tegeocranus cepheiformis. Nic. 465.

Found by Mr. George at Kirton Lindsey and by me at Epping Forest; not uncommon.

The English specimens have not the two hairs on the vertex figured by Nicolet, and they have two pairs of hairs in front of the mouth instead of one.

I have retained Koch's name, being unable to see why Nicolet has rechristened this and bestowed Koch's name on a different creature (discovered by Nicolet).

This is the species above referred to, of which I have bred the very singular larva and nymph, neither of which have, I believe,

been before observed, and seen the latter change to the perfect form.

Larva a flattened ellipse, truncated anteriorly; dorsal surface coarsely reticulated, with a round opaque central spot. From the edge of the body project ten long, clear, stout spines, each doubly curved, so as to approach the line of beauty in shape, and armed with short spikes at intervals. Two rows of four similar spines on back.

The nymph is similar in shape, but the form of the ellipse becomes broader with each change of skin; it does not lose the whole of the larval skin, but carries the dorso-abdominal portion of that and of its own cast skins, *in situ* on the back, lying flat, and concentrically. Texture same as larva, colour a trifle darker with each change of skin. From the edge of the dorsal skin proceed sixteen large trifid, or quadruple, somewhat chitinous projections, the form and arrangement of which will be best understood by reference to Plate IX. Fig. 2; the central lobe of each projection carries a spine like the larval one, inserted (in appearance) like a bird's quill; the small pointed portion of the projection which springs from the base of this spine, as shown in the figure, is absent in some specimens. The spines and projections occurring on each skin give the creature an effect of great complication. It lives on the bark of old trees, under moss, and keeps flat on the wood, thus its spines must form an efficient protection.

Tegeocranus coriaceus. Koch. Pl. XI. Fig. 1.

37. *Carabodes coriaceus.* Koch, fasc. 3, pl. 15.

Average length about ·62 mm.
" breadth " ·4 "

Found at Epping Forest.

Opening for mouth organs almost entirely closed by *labium*; second joint of *palpus* only slightly thicker than third, fifth joint not toothed; mandibles short and strong. Whole creature very black, but dark red brown where seen by transmitted light (as in the stigmata).

Form short and broad; *cephalothorax* very broad, flat, triangular, and joined to abdomen by the full breadth of the former; median part (longitudinally) depressed and lighter in colour; central (also longitudinally) in this light space are two small raised black ridges, so close together as to appear one; these commence in the centre of the cephalothorax and extend back to near the abdomen, then cease abruptly. Sides of cephalothorax raised along the whole length, extending laterally into broad, horizontal expansions, pointed anteriorly, broadest posteriorly, where they turn inwards at acute angles, become more raised, as though turned on edge, and follow the curve of the abdomen; before reaching the

median line they expand into rounded lumps, which are the most raised, and then become narrower and turn back to meet the lateral expansions: between the two lumps and opposite the termination of the first-named ridges is a narrow depression, not quite down to the level of the cephalothorax; this communicates with a deep and wide depressed channel between cephalothorax and abdomen: from near the ends of this channel proceeds a smaller one which runs round the abdomen. There is a raised, rough, exterior margin, which is prolonged into small angular corners; within this channel the abdomen is almost circular, and much raised and marked like morocco leather, whence doubtless Koch's name. Stigmata large, raised, and pointed outward, stigmatic hairs curved forward and thickened towards the ends; two rows of about four rather spatulate white hairs on the back, and some shorter, projecting from posterior margin. First pair of legs inserted in a deep cleft of cephalothorax, which is open above and below; second pair supported by a projecting plate. All trochanters, but particularly first pair, very thin where inserted, and greatly and suddenly thickened towards the middle.

Lives chiefly in fungi growing on old trees.

38. Tegeocranus labyrinthicus. Mihi, Pl. XI. Fig. 2.

Average length about ·45 mm.
„ breadth „ ·25 mm.

New Species.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest and near Tamworth.

A small species, of a deep red brown colour, the whole creature covered with raised dots, close together and often coalescing, arranged in winding lines leaving narrow depressions between.

Cephalothorax triangular, broad, and joined by its whole width to the abdomen. Along whole length of cephalothorax runs a broad, free, raised, reticulated expansion, about equal in width until near its anterior point, but having a semilunar depression in the margin near where it joins the abdomen. Stigmatic hairs with thin stalks and piriform, clubbed ends. First and second pairs of legs set in shallow clefts of cephalothorax; all trochanters enlarged beyond the middle. The *abdomen* has the sides almost parallel, hind margin rounded, anterior ditto truncated and only slightly curved. The border usually found round the abdomen in this genus is wanting or rudimentary, but the anterior angles are expanded adjoining the cephalothorax. A row of short, straight hairs round the hind margin.

I believe this species to be unrecorded, and propose to call it *labyrinthicus*, from the maze-like arrangement of the rows of dots on the back.

39. Tegeocranus elongatus. Mihi, Pl. X. Fig. 7.

Average length about ·68 mm.
„ breadth „ ·32 „ at broadest part of abdomen.
„ „ ·2 „ where abdomen joins cephalothorax.

New Species.

Colour black; whole creature from point of rostrum to anus a very long piriform shape, broadest near posterior end, which is rounded, the line of the cephalothorax running continuously with the abdomen in shape, but the wings of the cephalothorax standing beyond the line.

Cephalothorax long, a third of the length of the whole creature, conical, nearly flat, sides raised into projecting wings, almost horizontal. Anterior surface of the vertex covered with slightly raised irregular ridges. Stigmata at the extreme edge and posterior limit of cephalothorax. Stigmatic hairs short, slightly curved back, gradually thickened towards the end, which is rather bilobed. Hairs of the vertex very long, almost reaching the point of the rostrum; a hair from beyond the middle of each wing-like ridge curved over the rostrum, the two crossing; two shorter hairs near point of rostrum curving downwards. Last two joints of the legs slighter than usual in the genus. Abdomen coarsely reticulated, nearly straight anteriorly, with two small, projecting, blunt points; border of abdomen narrow and with rough edge, four lines of long hairs down its dorsal surface, and a line of strongly recurved shorter ones round the edge. On the ventral surface, below the wing-like edges, is seen, on each side, a shorter similar ridge, reticulated, and armed with three curved teeth on the anterior edge. Genital plates much rounded.

This creature is exceptional amongst the *Tegeocrani* from its lengthened form, otherwise it presents all characteristics of the genus.

I believe it to be unrecorded, and propose to call it *Tegeocranus elongatus*.

It lives in dead wood and is very sluggish.

GENUS HERMANNIA.

40. Hermannia piceus. Koch.

Nothrus piceus. Koch, fasc. 29, pl. 2.
Hermannia crassipes. Nic. 469.
„ „ Murray.
(?) *Hermannia reticulata*. Thörell, loc. cit. Nymph.

Found everywhere. Common.

Thörell's description of his *reticulata*, found at Bell Sound, appears to correspond with the adult nymph of this species.

41. HERMANNIA ARRECTA. Nic.

Nic. 470.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest. Not uncommon.

GENUS HOPLOPHORA.

42. HOPLOPHORA MAGNA. Nic.

Nic. 472.

Found by Mr. George at Kirton Lindsey, and by me at Epping Forest and Loch Maree. Not uncommon in dead wood.

43. HOPLOPHORA STRICULA. Koch.

Koch, fasc. 2, pl. 10.
Nic. 472.

Found at Kirton Lindsey by Mr. George, and by me at Epping Forest.

44. HOPLOPHORA DASYPUS. Dugès.

Oribata dasypus. Dugès, 'Mémoire sur l'ordre des Acariens,' 47.
Hoplophora contractilis. Clap., 'Studien an Acariden.'
" " Murray, 222.
Phthiracarus contractilis. Perty.
Hoplophora nitens. Langle (unpublished).
" " Nic. 423.

Common everywhere in dead wood.

I do not see why Dugès' name, which seems to be the earliest, has been abandoned; I have therefore used it.

XIII.—*Notes on the Pygidia and Cerci of Insects.*

By Henry Davis, F.R.M.S.

(*Read* 13*th November*, 1878.)

Some years ago most microscopists quoted the pygidium of a flea as being one of the best of definition tests, and although doubtless it is now well known as being so variable, that for comparative trials (where objectives are not tested on the same specimen) it is practically of little value; still its delicate beauty, the puzzle as to its function, and the fact of its being generally considered as an organ unique amongst insects, keep it to the present day as an object of abiding interest, and one without which no cabinet would be called complete.

As one of its early admirers, I gave it, some years ago, considerable attention, and was able not only to convince myself that the angular, square-shouldered outline of the rays in the areola, thus figured in the 'Micrographic Dictionary,' has no foundation in fact, but that those areolæ possess some outer structure which seems hitherto to have escaped notice. It has afforded me a somewhat malicious pleasure in challenging those of my friends who used high modern powers, to discover this structure for themselves. They invariably failed. A small-angled ¼-inch objective, fully twenty years old, first showed that, looking on an areola as representing a carriage wheel, a line proceeds outwards from the tire between each spoke, and these lines being bounded by a circle, give resemblance to a wheel within a wheel: the new wheel or circular band is, when the object is unflattened by pressure, at right angles to the plane of the inner wheel; the first forming the sides, and the latter the bottom of a little pit, from the centre of which springs the well-known fine long hair.

This is not brought forward for the purpose of glorifying old objectives, or decrying the power, optical and manipulatory, of certain microscopists, but rather to show the advantage of mounting one's own preparations; for the structure can only be well made out when the object is placed in a position which a professional mounter would endeavour to avoid and consider as wrong side out.

Until 1870, when Mr. Peake discovered a pair of pygidia on the Lace-wing fly (*Chrysopa peola*), the Flea appears to have been the only insect known to possess this appendage, and, after diligent inquiry, I cannot find that since that date any published addition has been made to the number. But in December, 1870, it was my fortune to notice two pygidia on a fine Locust (*Locusta migratoria*) I had captured near Cadiz, and after finding these the road was made to very many discoveries in other, mostly allied, insects. It

will be a safe, because an under, statement to say, that without any special search, fifty insects of different species are now proved to possess pygidia. The organ is here spoken of in the plural, as with the single exception furnished by *Pulex*, all the insects examined have it in pairs more or less separated; even in the Flea it is distinctly double and bilateral, and I submit it should no longer receive the singular appellation except when divided.

It would doubtless be satisfactory to give a full list of all the insects on which I have found pygidia, but it happens that by far the greater number are exotic, taken, some at the Cape of Good Hope, some in Mauritius, and other places abroad; the correct naming is a difficult task; even Mr. Frederick Smith of the British Museum shrank from it, and I am constrained to speak of the foreign species in general terms, but will give particular examples in common English insects.

The pygidia of the Lace-wing may be taken first, as introductory to a series gradually increasing in size; they are found as nearly circular, flat, or slightly convex plates, one on each side of the last (posterior) joint of the abdomen; they are dorsal, and only require to be pushed (so to speak) closer together to be exact copies of the pygidia of the Flea. It has a similar collection of the same shaped areolæ and the same characteristic fine long central hair. Next to this, as having pygidia of the nearest resemblance to that of the Lace-wing, comes the common small Grasshopper (*Gryllus*); in this the organs project slightly, conical in figure and somewhat flattened at the sides, but otherwise they are exactly similar to the only pygidia hitherto known. In the large Grasshopper (*Acrida viridissima*) the parts are much longer and not easily overlooked, while in the Cricket (*Acheta domestica*) we find these same organs extended to an immense length—sometimes three-quarters of an inch—but still bearing the peculiar structure of rayed and haired areolæ. The Mole Cricket (*Gryllotalpa vulgaris*) also has large and beautifully marked pygidia.

In the Cock-roach (*Blatta orientalis*) may be found corresponding large appendages, which are called *cerci* by Burmeister; except in position, there is little at a glance to identify them with the parts we have seen. They are nearly bare on the superior surface, and the under side, often turned upwards and outwards, only is furnished with any long hairs; nor are these set in broad, deep sockets like those described, but are attached to small, clear, unrayed spaces, flush with the chitinous integument. To found a belief that these cerci are really pygidia, it requires considerable acquaintance with the latter's various modifications, and, above all, a knowledge of the very peculiar properties of the long hairs to be mentioned presently.

Of foreign insects having pygidia, I purpose saying little,

although they have supplied the greatest number and variety of examples. Among these it really would seem as if all the orthopterous insects have them, and most of the Neuroptera. Some are very minute, even when the owner is of large size; others greatly elongated, as in *Lucina opilioides*, where the organ is over an inch long. Curious instances may be found in *Thuxalis*, in *Heterodes;* also in an Indian Grasshopper (possibly anonymous), which has the organ twisted, and tipped with a hard serrated hook.

As regards the function of pygidia, it might appear, at first sight, that the new examples being mostly of large size, there would be little difficulty in investigating and determining a matter which, in the case of Pulex, has vainly taxed the skill, patience, and acumen of many excellent observers; and probably if the subject were taken up again by biologists well versed in the anatomy and physiology of insects, satisfactory results might accrue; but as a matter of fact, the inquiry is by no means an easy one, and after considerable study of fine and various specimens, I, for a long time, only arrived at a conclusion—an old one, it would seem, of the late Mr. Richard Beck—that pygidia are collections of tactile hairs forming posterior feelers; but quite lately, almost by an accident, I was enabled to see that, while they may be this, they certainly are something, and very much, more.

I had a pygidium of a Cricket under a low power, and was surprised to see a strong, waving motion in the hairs; this, at first, was attributed to action imparted at the will of the insect, although it was at the time stupefied and quieted with chloroform; but the same sort of movement occurred when the creature was quite dead, and when only a thin section of the organ was under the Microscope. It was found that the hairs are so light and so delicately attached, that the ordinary breathing of the observer, at fully ten inches distance, set them in motion; and a slight movement of the hand a foot or more away caused a visible disturbance, which is not a mere vibration, but a rocking of the motile hair in its socket, and of the disk by which it is attached. In repeating this experiment, it is necessary to examine the part within a short time of the death of the insect, and before the *rigor mortis* has set in; otherwise the little disk at the base of the hair (sometimes there is a rounded end, but never a root) will become more or less firmly fastened to the white (nervous?) matter in which it seems set, and the hair will be found comparatively insensitive.

It will be seen that as mere tactile hairs they are far too delicate; moreover, examples may be found in some species of Lace-wing, and notably in the Flea of the Pigeon, where by being surrounded by coarse true hairs, or placed under stout curved spines, they are partly or wholly protected from contact with external bodies. I am led to believe pygidia to be collections of

motile hairs, forming organs of feeling induced by the movement of the air in their neighbourhood; not, perhaps, an organ of a new sense between touch and hearing, but of feeling not excited in the ordinary way by actual touch. I apprehend that any insect having pygidia must infallibly be warned of the approach, however stealthy, of an enemy; even if, from its position behind the insect, that enemy could not be seen, the warning being given by the moving hairs actuated by the disturbance of the surrounding air.

In these notes I think may be found reasons for discarding the use of the word "cerci," as applied to all those insect organs which are plainly modified forms of the better known "pygidia." The latter simply meaning something on the *uropigium*, will permit them to be of any form or size; and as "cerci" means tails, it is absurd to apply it to objects of no length, as the pygidia of *Chrysopa* and *Pulex*. But if these be tails, then indeed man himself has one.

XIV.—*On Stephenson's System of Homogeneous Immersion for Microscope Objectives.**

By Professor E. Abbe, of Jena, Hon.F.R.M.S.

(*Read 12th March*, 1879.)

The inventor of the Immersion method, Amici, with whose name so many important improvements in the Microscope are connected, attempted to use other fluids than water for the immersion medium. Amongst others he tried the highly refractive oil of aniseed, probably from the idea that the advantage obtained by replacing the stratum of air by a more refractive medium would increase with the increase in the refractive indices of the media employed. More recently others have used glycerine, and the well-known American optician Spencer has, according to report, produced objectives by this means of excellent quality.

The theoretical analysis of the immersion principle shows, that in several respects far more favourable results can be attained with a highly refracting substance than with water: it proves, however, at the same time, that the advantage to be expected is by no means proportional with the progressive increase in the refractive index; on the contrary, there is a maximum beyond which the results become less favourable. When the cover-glass and the front lens are of crown-glass, which is generally the case, this maximum is reached when the immersion fluid has the same refractive index as crown glass. A connection, which is optically homogeneous, is then established between the preparation and the objective, which eliminates all refraction in front of the first spherical surface of the optical system. Not only is the loss of light by reflection obviated, a loss which is experienced at every surface separating different optical media when the incident rays are oblique, but what is still more important, a very considerable amount of spherical aberration is at the same time prevented which otherwise would have to be corrected in the upper portion of the objective, but which must leave a residuum. Apart therefore from other advantages, such a method of "homogeneous immersion" gives promise at all events of a more perfect elimination of spherical aberration, and consequently more favourable conditions for what is called "definition" of the objective, than water immersion. It also possesses the further advantage, which is by no means inconsiderable, of getting rid of the disturbing influence of the cover-glass and doing away entirely with the otherwise indispensable correction. For where the intervening medium is equal in its refraction and dispersion to the cover-glass, it is immaterial, as regards the optical effect, whether a

* Translated by R. Woodall, Esq., F.R.M.S.

thicker layer of glass and a corresponding thinner layer of the fluid, or *vice versâ*, is inserted between the object and the objective.

The idea of realizing the various advantages of such a kind of immersion, by constructing objectives on this system, had for some time presented itself to my mind, but I thought that there was not much to be expected, as regards the scientific usefulness of such objectives, as I believed their use would be limited on account of the necessity of using oil or some other inconvenient material as the immersion fluid. It appeared to me that, except perhaps for the examination of diatoms, scarcely any other scientific sphere remained than petrographic research, which would afford scope for realizing the optical advantages of such objectives.

The matter assumed, however, subsequently a different shape in consequence of a suggestion made by Mr. John Ware Stephenson (the Treasurer of the Royal Microscopical Society of London), who independently discovered the principle of Homogeneous Immersion,* but by whom, in addition to its other advantages, special attention was drawn to the doing away with the cover-glass correction, and to the possible enlargement of the angular aperture, with consequent increase in the resolving power of the objective. This idea of Mr. Stephenson, which made the matter one of universal scientific interest, was at once followed out, the calculations being made by me, and the technical execution by Mr. Zeiss, and resulted in the production of a series of objectives on this system which in several respects are manifestly superior to the ordinary water-immersion objectives. Having now been used by a number of microscopists, it has been found, that although the nature of the peculiar immersion fluid will naturally much restrict the employment of such objectives, it does not present any obstacle to their use in various widely different spheres of microscopic research; and in particular, biology furnishes many problems to which the new lenses may render useful service.

Since the construction, about a year ago, of the first objectives on this system, the focus being $\frac{1}{8}''$ nominal (more exactly 2·6 mm. equivalent focus), and all of them calculated for the long tubes of the English Microscopes, some have been made of $\frac{1}{12}''$ (1·8 mm.), which give sufficient magnifying power, even with the shorter tubes of the continental instruments; and quite recently a third series, $\frac{1}{18}''$ nominal (1·2 mm. focus) has been produced, by which, especially in histological observations, great amplification can be obtained with low eye-pieces.

The angular aperture of all these objectives is about 114° in the immersion fluid for which they are adapted, the index of refraction being taken in round numbers as $= 1 \cdot 50$.

* J. W. Stephenson "On a Large-angled Immersion Objective without Adjustment Collar," &c.—This journal, i. (1878) 51.

This is approximately the same *angular* magnitude as can be attained without any great difficulty within the film of water in the usual immersion lenses, or within the stratum of air in dry objectives. But since the "numerical" equivalent of the angle of aperture (the measure which determines the number of rays taken in by the objective) is proportional not only to the sine of half the angle of aperture, but also to the refractive indices of the respective media employed, and since all the functions of the angle of aperture, and especially the resolving power of the Microscope, are regulated by this numerical equivalent, it follows that, according to theory, the capacity of the new objective, compared with that of ordinary immersion lenses, is increased in the proportion of 1·50 to 1·33, and as compared with the highest dry objectives, as 1·50 to 1.

The product of the sine of half the angle of aperture into the refractive index of the medium—the "numerical aperture," as I call it—reaches 1·25 to 1·27 in these objectives. The ratio of these figures to unity expresses how much greater is the number of rays admitted by the new objectives, over that number which *in air* would fill a complete hemisphere, or which would be admitted by an imaginary dry objective of 180° aperture.

This unusually large aperture is accompanied with a notable increase of resolving power. This is at once evident by the facility with which very fine striæ and similar markings become visible on the more difficult test objects; by the plainness with which the characteristic markings stand out on the more complicated forms, such as *Frustulia saxonica*, *Surirella gemma*, &c.; and lastly, by several unusual features which appear when certain methods of illumination are employed on the coarser tests of this kind, e. g. *P. angulatum*.

Histological preparations also furnish instances of very small elements closely clustered together, granulations and such like, in which clearer and more definite resolution is obtained in critical cases.

At the same time, in all these objects, especially in those last named, the decidedly more perfect definition which homogeneous immersion renders possible, is obtained, provided that the precision of the technical execution is adequate to the reduction effected in the residual aberration as indicated in theory. Therefore, when comparatively strong eye-pieces are used the image retains great sharpness, so that in regular work higher amplification can be usefully employed than is usually the case with other objectives of equal focal length. They also often enable more exact observations to be made of very delicate objects, such as fine cilia, than good immersion objectives of the ordinary kind would permit.

Lastly, as a proof of excellence of definition which, though indirect, is of special weight, may be mentioned the favourable

results which Dr. Koch, of Wollstein, obtained when examining bacteria,* viz. by employing a full cone of rays filling the entire aperture of the objective, a method of illumination quite unheard of as applied to such objects and with such an angular aperture. With this illumination, which can only be effected by the aid of a condenser of large aperture, the preparation is simultaneously penetrated in all directions by the incident rays. As a result, the delineation of such parts as stand out in mutual contrast through difference in refractive power (tissue structures, &c.), is almost completely suppressed, and there remain visible only those elements which act as absorbents through staining. On the other hand, the essential advantages of oblique illumination are retained, although the illumination remains central in name, in consequence of the co-operation of the rays incident at a large angle towards the axis of the Microscope. Very small and closely clustered elements, as in preparations of bacteria, must certainly on both these accounts become capable of a more thorough resolution than with central illumination of the usual kind; if, however, this ingenious method of observation is to show corresponding results, the defining properties of the objective must stand a most severe test, and this test will be the more severe in proportion to the magnitude of the angular aperture employed.

As regards the nature of the immersion fluid, it is of course on optical grounds a matter of indifference what is selected, so long only as it is homogeneous and transparent, and equal, or very nearly equal, to crown glass in refraction and dispersion. Experiment has taught, however, that this condition of homogeneous immersion leaves a much smaller choice than might be anticipated. At the outset I examined over one hundred fluids of the most varied kinds—essential and fatty oils and artificial chemical preparations—which I either tested myself or caused to be examined with the refractometer, to determine their refractive and dispersive indices, and lately the investigation has been carried still further by Dr. Töpel, who, under my guidance, determined the optical constants of nearly two hundred chemical combinations from the collection in the laboratory of the Jena University, which Professor Geuther was kind enough to place at our disposal. Among all these, however, not one was found which from its other properties could be used; which either alone or mixed with other fluids attained the refractive index of crown glass (1·515 to 1·520 for sodium light) without at the same time more or less exceeding the dispersion of crown glass. A few only of the substances examined satisfied the necessary conditions with sufficient accuracy to permit the deviation to be regarded as unimportant.

The most suitable fluid that has at present been discovered, is

* 'Aetiologie der Wundinfektions-Krankheiten.' Leipsic, 1879.

cedar-wood oil (prepared by Schimmel and Co., Leipsic and New York) an essential oil almost without colour or smell, and not volatile, but unfortunately rather thin. Its refractive index at a medium temperature is about 1·51, whilst the dispersion only slightly exceeds that of crown glass. The objectives have therefore been constructed for use with this oil.

For a more extended application of the principle of homogeneous immersion great advantage is derived from the fact, that by mixing one of the more highly refracting essential oils, such as oil of cloves, fennel, aniseed, or others, with a certain quantity of olive oil, fluids can be readily obtained which are equal to cedar-wood oil in refractive power, but whose dispersive power may be increased more or less, as required. This provides a means of regulating the chromatic correction of greater delicacy than is attainable by any mere mechanical correction, inasmuch as for cedar-wood oil can be substituted mixtures of various dispersive power, according to the nature of the object to be examined and the kind of illumination required. By this simple means, for example, the chromatic difference of spherical aberration, a correction-defect which (in the present state of practical optics) it is impossible to overcome in objectives of large aperture, is rendered for the most part immaterial. This unavoidable defect is apparent from the fact that the central and peripheral zones of the objective are never simultaneously perfectly achromatic. An objective which with oblique light gives an image as free from colour as possible, is found, when central illumination is used, to be chromatically under-corrected to a marked degree, in the case of a sensitive object, and conversely. This is the more striking the larger the angular aperture. If, now, instead of a stratum (with parallel surfaces) placed in the course of the rays we substitute another of equal refractive but different dispersive power, we obtain a simple means of changing the chromatic correction of the objective without altering the spherical correction, and if, as is done throughout in the construction of these lenses, the chromatic compensation is so arranged that the fluid having the lowest dispersion (cedar-wood oil) produces the best achromatism for oblique light, the use of a more highly dispersive mixture of the kind mentioned will correct the chromatic defect for central illumination which would otherwise appear.

The application of this method is adversely affected by one circumstance only, viz., that the effect of a determinate increase in the dispersion naturally depends upon the thickness of the fluid stratum. With covering glasses of different thickness, as also with objectives of different focal lengths and corresponding different working distances, one and the same mixture will yield more or less unequal results.

Since the exact adjustment of the immersion fluid thus appears

essentially necessary if the capacity of the new objectives is to be fully utilized, it is important to have a simple means of regulating the refractive and dispersive powers of the fluids in their relation to the corresponding factors in crown glass without having to employ special measuring apparatus. For this purpose Mr. Zeiss furnishes with each objective a small glass bottle with parallel sides, to the glass stopper of which is cemented a crown glass equilateral prism. This test bottle may be used in preparing the combined fluids, and by viewing the vertical bar of a window frame, &c., through both fluid and prism the difference between the fluid and crown glass, both with respect to refraction and dispersion, may be at once seen. The deflection of the image of the vertical bar in passing through the prism, and the width of the coloured border, gives both these elements at a glance and with an exactness which is quite sufficient.

In the practical use of the new objective there are two further points to be specially noticed. The first is its dependence upon the length of the tube. The abolition of the cover-glass correction in these objectives, which is acknowledged by all observers to be an extraordinary advantage in manipulating the lenses with ease and certainty, nevertheless deprives the observer of a convenient means of compensating within certain limits the influence of different tube-lengths upon the aberrations.*

The objectives can therefore only be used with the length of tube for which they are originally adjusted, and they are so sensitive on this point (especially the lowest power) in consequence of the large angular aperture, that a deviation of a very few centimetres in the length of the tube produces visible changes in the condition of the correction. A draw tube to the Microscope affords therefore a very simple means of regulating according to the observer's own judgment, the ultimate more delicate adjustment of the correction, and also enables him—until some better immersion fluid is found—to compensate any small defect in the refraction of cedar-wood oil, which may be noticeable when very thick or very thin cover-glasses are used. (As lengthening the tube produces spherical over-correction, and shortening under-correction, it follows that the former corrects a very thin covering glass, and the latter one of more than ordinary thickness.)

* Dispensing with the correction-adjustment in the manufacture of such objectives is a matter of small moment in itself when compared with the other technical requirements which are met by it. An essential benefit arises, however, from the simplification of the mechanical construction, in so far as it would scarcely be possible in a combination of lenses with *movable* parts to get the lenses centered as perfectly and durably as is possible in the case of a fixed combination: and in the present instance this appears an indispensable condition on account of the sensitiveness of the large aperture to the slightest defect in centering. Looking at this circumstance, it would be most unadvisable to provide such objectives with correction collars.

In using the objectives for photography, where the image must be at a considerable distance, unless an ordinary low eye-piece is used to photograph with, an auxiliary lens becomes requisite, which will remove the image to the required distance, without altering the course of the rays in the objective itself. For this purpose a concave lens of suitable focal length may be inserted close behind the objective in the same way as a short-sighted person uses concave spectacles to move the plane of distinct vision to a greater distance; a concave lens of relatively corresponding shorter focal length may also be interposed at a greater distance from the objective, in order to produce a moderate amplification (two or three times) of the image, and at the same time a decrease in the requisite distance of the plate. The position of the auxiliary lens in this case must of course be so regulated, by computation, that the cones of rays emerging from the objective converge towards the same plane as in ordinary observation.

A second point which must not be lost sight of in using these objectives—and in fact any objective the numerical aperture of which considerably exceeds the value 1—relates to the conditions which the illuminating apparatus must satisfy, in order that the whole angular aperture may be utilized with oblique illumination.

With a numerical aperture of 1·25 an incident ray, if it is to reach the external zone of the objective, must, when it impinges on the object, be incident towards the axis of the Microscope at an angle of about 56°. Rays with this inclination cannot of course be transmitted to the objective out of air through a flat surface perpendicular to the axis, such as the lower surface of the glass slide. An incident ray reaching this surface from below would not, after entering the glass, be inclined towards the axis more than about 42°; and with the ordinary illuminating mirror even this obliquity could never be attained, apart from the great loss of light by reflection, which would greatly detract from the effect. In order therefore to utilize the maximum degree of oblique illumination, which an objective of such large aperture will admit—of course with objects which do not lie in air—and to bring out the full defining power of the objective, an illuminating apparatus is necessary, which not only gives a cone of rays of equal aperture with the objective, but which at the same time admits of a fluid connection with the under side of the slide. One immersion condenser amongst others which fulfils these conditions, is the illuminating apparatus described by me * some years ago, the system of lenses in which (corresponding with the angle of aperture of the older immersion objectives of Zeiss) possesses a "numerical aperture" of over 1·1 for its upper focus, and in the construction of which the

* Max Schultze's 'Archiv f. Mikr. Anat.,' ix. 496.

connection of the front lens with the under surface of the slide by a drop of water, is taken into account.* In the absence however of an illuminating apparatus such as this, and where only very oblique illumination is required, a much more simple arrangement will be found very serviceable, which consists in connecting, by means of a drop of glycerine or oil, a plano-convex lens, nearly hemispherical, of 6–9 mm. radius, to the under surface of the slide, to which it will adhere. It may be kept sufficiently centered by means of a loose brass ring attached to it, having an external diameter equal to that of the stage aperture. The ordinary concave mirror, turned slightly outside the axis of the Microscope, will then give cones of rays of any degree of obliquity which may be desired.

In conclusion, some account may be given of the optical combinations of the objectives for homogeneous immersion. Those constructed in Mr. Zeiss' manufactory, and based upon my computations, are all systems with four members. In this I have gone back to a type of construction which was applied by me experimentally many years ago, and has lately been used with considerable success by several opticians, especially Mr. Tolles and Mr. Spencer. Two single crown-glass lenses close together are made use of (duplex front) as the lower members of the system, and the two others only are compound, so-called achromatic (in the present case binary) lenses.

This form has certainly the disadvantage of leaving rather more chromatic difference of the magnifying power (that is, with perfect achromatism in the middle of the field of view there is more colour towards the periphery) than is usually found when the front lens of the system is followed immediately by a compound lens of flint and crown glass; but this defect is practically inconsiderable in comparison with the facility with which it enables the angle of aperture to be increased. The form in which I have devised this type is nevertheless essentially different from the construction of which Mr. Tolles has published the elements in detail.† The difference becomes very apparent when the radii of the front lenses are compared with the equivalent focal distances of the respective objectives. The $\frac{1}{6}''$ objective of Tolles, described in the journal referred to, has almost exactly 4 mm. focal length, and its front lens a radius of 0·73 mm. In Zeiss's $\frac{1}{12}''$, with 1·8 mm. of focal length—consequently less than half—the radius of the front lens is no less than

* In consequence of the greater aperture of the objectives for homogeneous immersion, I have recently had a system of lenses constructed for an illuminating apparatus, the angular aperture of which reaches approximately the numerical equivalent 1·4. This will consequently give rays which are inclined 72° towards the axis in glass.

† This Journal, i. (1878) 143.

0·9 mm., and even with the $\frac{1}{18}''$ (1·2 mm. focal length) the smallest radius (0·6 mm.) is very little less than that of Tolles's $\frac{1}{8}''$, whilst an objective of equal power would require, according to Tolles's formula, the abnormally small radius of 0·22 mm.

For the advantageous application of the duplex front in obtaining larger angular aperture, the more favourable ratio between the radius of the front lens and the focal length which is here attained will be of some importance, because it provides the only possible means of producing objectives of great magnifying power, without having too much recourse to the tube and eye-piece for amplification. By Tolles's construction it would be practically impossible to make an objective such as Zeiss's $\frac{1}{12}''$, not to mention the $\frac{1}{18}''$, with an angle of aperture of any considerable extent, to say nothing of the intolerable limitation of the working distance of lenses so abnormally small.

As far as the mere observation of diatoms and similar test-objects is concerned, an objective of 4 mm., if thoroughly well made and possessing a good large angle of aperture, would indeed leave scarcely anything to be desired, especially as the small front lens of Tolles's construction involves relatively favourable conditions for the employment of deep eye-pieces. But when we take into consideration the much more complicated structures of the difficult objects of biological research, it cannot be doubted that systems which give considerably higher *objective* amplification will remain a real necessity until in practical optics more perfect methods of getting rid of the aberration than at present known are discovered. In my opinion, therefore, looking to general scientific requirements, the end to be kept in view at present is the production of objectives of sufficiently *short* focal length, which do not present too much difficulty in ordinary use, and this has been the principle which has guided me in my labours in this particular case.

A decidedly unfavourable feature in the formula which I have produced is the technical difficulty of construction, in which requirements are made such as were scarcely ever demanded and satisfied in the manufacture of Microscopes. In this construction the spherical surface of the front lens must be utilized to an extreme extent, and must bear angles of incidence which for the marginal rays (on the air side) exceed 45°. The manufacturing optician has therefore to produce spherical surfaces of the small dimensions of the front lens, which shall be strictly true in form to the extent of a full hemisphere, and afterwards to mount these lenses in such a manner that without affecting the firmness of their setting they shall freely admit rays of light nearly up to the equator. The difficulty of this work and the extreme sensitiveness to the least defect of form and centering of the lenses, in a system of so great an angular aperture, make the production of such objectives an

exceptionally troublesome and delicate task. All these difficulties of technical execution would, however, be considerably diminished if the increase in the angular aperture were to some extent sacrificed and we were content with a numerical aperture of 1· to 1·1, which has hitherto been the ordinary aperture of immersion lenses.

I must for the present leave undecided the question whether the Stephenson immersion system might not prove of great practical service even under such restrictions. Of course such advantages would be surrendered as arise from the augmented resolving power, since this is essentially determined by the magnitude of the aperture. But there are surely objects enough in the domain of the microscopist, with respect to which a specially high resolving power is of less moment than the greatest possible perfection of definition; and the superiority of the homogeneous immersion system on this point, and the great advantage which the elimination of the disturbing effect of the cover-glass involves, would be diminished only to a very limited extent with a reduced angle of aperture. Assuming, therefore, that the nature of the immersion fluid admits the frequent use of such lenses, especially in biological researches, it might be desirable to try the system of homogeneous immersion in objectives of more simple construction, which would by their smaller cost be more generally used.

In the other direction, however, the extent to which the new immersion method will lead us has been by no means exhausted by the new objectives. From the result of the first step it cannot be doubted but that by this system considerably larger apertures of moderately short focal length are still attainable, notwithstanding the increasing difficulties of computation and construction. It being unquestionably a matter of interest to extend the resolving power of the instrument to its extreme limits by any means in our power, even if the unavoidable refinements in such objectives scarcely admit of their frequent application, the attempt has been undertaken in the optical manufactory here. I hope soon to be able to show objectives of 4–3 millimetres focal length, the numerical aperture of which is increased to 1·35, corresponding to an aperture angle of 128° in a medium with an index of 1·50. This figure, however, would be the extreme limit which can at present be attained, unless cover-glasses of flint glass are used for the object, and at the same time an immersion fluid of corresponding refractive index is applied.

XV.—*The Vertical Illuminator and Homogeneous Immersion Objectives.* By J. W. Stephenson, F.R.A.S., Treas. R.M.S.

(*Read 9th April*, 1879.)

The Fellows will have seen in the April number of the Journal (p. 194) a note extracted from the 'American Naturalist' for February, in which are described the advantages found by Mr. Morehouse, of New York, to be obtained from the use of the Vertical Illuminator * in the resolution of Diatoms and Podura scales.

On reading the note, I tried the apparatus on both classes of objects, and can fully endorse the statement made as to the surprising results obtained. Slides of *A. pellucida* which were deemed worthless because all the striæ had, as was supposed, been destroyed in cleaning, were resolved with the greatest ease, and Podura showed parallel light or white lines from one end of the scale to the other, somewhat reminding one of Lepisma. The Vertical Illuminator was soon after its first invention discarded by practical microscopists on account of the amount of fog which was caused by the reflection, at the upper surface of the cover-glass, of the rays transmitted through the objective. It is obvious that *this* fog will not be observed when an oil-immersion objective is used, as in that case the front lens of the objective, the intervening stratum of oil, and the cover-glass itself, are all optically continuous, so that the upper surface of the cover-glass has optically ceased to exist, the only reflection being from its under surface when dry objects are used. An additional advantage is therefore found for homogeneous-immersion objectives.

My object is not, however, to deal with this branch of the subject, but with an entirely different application of the Illuminator, not noticed by Mr. Morehouse, but which appears to me to be of great scientific interest.

This point is the *visible* demonstration which the Vertical Illuminator affords, not only that many modern objectives, and notably those on the homogeneous-immersion system, have angles far exceeding the equivalent angle of 180°, but also that the extent to which this excess is in any particular case carried, can at once be appreciated.

The existence of this excess, although at one time doubted, has

* As several inquiries have been made as to what instrument is meant by the "Vertical Illuminator," I may refer to Dr. Carpenter 'On the Microscope,' 5th ed., p. 153, where the instrument is both described and figured. A small silver speculum (Professor Smith), or a movable disk of thin glass (Messrs. Beck), or a piece of parallel glass fixed at an angle of 45° (Messrs. Powell and Lealand), is fixed in a short tube (with a side aperture) interposed between the objective and the body of the Microscope, by which means a pencil of light entering at the aperture and striking against the speculum or inclined surface of the disk or plate, is reflected downwards through the objective upon the object.

since been abundantly proved, and the present method affords an ocular demonstration of the fact, most conclusive in its character and fully supported by theory.

It will be seen, on removing the eye-piece of the Microscope, after having reflected a full beam of light through the objective, by means of the Illuminator, and after having focussed the instrument on any dry object adhering to the cover, that within the margin of the lens there exists a brilliant annulus of light, and that the circumscribed internal space appears by comparison to be quite dark.

This annulus represents, and is produced by, the excess of aperture beyond the equivalent angle of 180°, or what is called the "*plus* 180°," of which it is also the measure.

The internal dark space is of the exact diameter of that of a dry objective of the same focus, and is in fact the maximum space which it can itself utilize, on a dry object, by transmitted light.

On looking down the tube of the Microscope on which is one of Zeiss's homogeneous-immersion $\frac{1}{8}$ths, with its numerical aperture of 1·25, it will be seen that the annulus has an apparent magnitude corresponding with that attributed to it by theory, that is to say, a width equal to one-fourth part of the radius of the dark central space.

The explanation is, as it appears to me, simple enough: the beam of light reflected by the parallel glass plate of the Illuminator, is condensed by the objective, and brought to a focus on the under side of the thin glass cover, the oil (or other homogeneous fluid) having, thus far, allowed the light to be freely transmitted; but, at the focal point, having to pass from a denser to a rarer medium, the passage of all rays which exceed the critical angle (in this case 41°) is arrested, whilst those within that limit, or at all events the greater part of them, pass through the glass and are lost.

The bright image of the flame of the lamp, which is seen crossing the field of view, is therefore almost exclusively formed by the "*plus*" rays, which, being totally reflected as soon as they impinge on the air surface of the cover-glass, are sent back by the peripheral portion of the objective to the eye; it is thus evident that, unless the objective possessed the excess of aperture which we have been considering, the image could not be formed by the totally reflected rays, nor, if formed, could the reflected rays be taken up by the objective and transmitted to the eye.

These reflected rays, when seen without the eye-piece, form the bright annulus of light, and constitute, as has been shown, the aperture in excess of the 180° limit, which limit is itself as clearly indicated by the dark central area.

That this is not a mere theoretical or nominal increase is evident when we consider the areas of the transmitting portions of the lens, which are proportional to the squares of their numerical apertures or as 1 to 1·5625, so that the Vertical Illuminator picks

up the 0·5625 as against unity, which is the *ideal* maximum of the dry lens.

It is truly stated in the 'American Naturalist' that the Vertical Illuminator "can only be successfully used in conjunction with an objective of high balsam angle," and I hope the reason of this has been rendered clear.

In examining a dry object with reflected and transmitted light, the optical phenomena are reversed: with reflected light we have the bright annulus and dark centre; but, with light transmitted from below, we have the central portion of the lens traversed by the illuminating pencil, which is, however, unable to penetrate the dark circle by which it is surrounded.

On objects mounted in balsam (or fluid) the Vertical Illuminator fails, as far as resolution is concerned, and it is on these that the various sub-stage immersion illuminators come into play, their greater or less success depending exclusively on their ability to induce the dioptric beam to penetrate the magic circle beyond the limit of 180°, as unless the light can be seen to touch the margin of the lens, its full power has not been developed; hence it appears that "vertical" illumination, in some form, is the only means by which the whole of the resolving power of large-angled objectives can be utilized on dry slides, just as on balsam objects immersion illuminators are indispensable.

In the foregoing observations I have throughout spoken of the bright *ring* of light, and this may lead to the impression that the whole of this ring is used, but this is not so; in practice only a small portion is employed, the greater part being shut off by a suitable *external* diaphragm or stop, just as with immersion illuminators in the sub-stage a part only of the marginal rays are employed.

This seems to suggest the substitution of a small totally reflecting prism for the parallel plate of glass, which, projecting slightly over the margin of the lens, gives a much more brilliant beam of light, but it has the disadvantage of, to a certain extent, interfering with the diffraction spectra, and thus under some circumstances, so diminishing the aperture of the glass, as to interfere with its resolving power.

The Vertical Illuminator was originally intended to be used more as a Lieberkuhn for opaque illumination with medium powers, its present use not having been foreseen. That it can be so used with even greater effect on balsamed objects now, when homogeneous immersion objectives are used, is obvious, because the light passes as direct as it formerly did on to uncovered objects in air, both the upper and under surfaces of the thin glass cover having been optically abolished—but the number of balsam objects suitable for opaque illumination with powers as high as an $\frac{1}{8}$, is very limited.

XVI.—*Note on Diagrams (Plate XII.) exhibiting the Path of a Ray through Tolles' $\frac{1}{8}$ Immersion Objective.*

By Professor R. Keith.

(*Read 9th April*, 1879.)

I have sent with this note additional diagrams (Plate XII.) to aid in localizing the symbols and following out the formulæ used in the computation of the $\frac{1}{8}$ immersion objective made by Mr. R. B. Tolles and owned by Mr. Crisp.* The lines are not drawn to any scale, although the elements of the objective are entered upon the lines corresponding to those in the objective itself.

It will be observed that the ray of light finally emerges from the plane surface of the small lens without refraction. It is, of course, supposed to enter material of the same refractive power as the lens itself: meeting the point in discussion upheld by Mr. Wenham, viz. that there is some interior impossibility of using more than 82° of aperture in *balsam*. It will be further observed that the ray meets the plane surface at an angle of over 55°, and therefore if that surface divides the glass from *air*, it cannot pass out of the lens; since at 41° and upwards the effect of the great difference of density between glass and air is to stop the light. It is thus seen that the limit of aperture in air does not indicate the limit of aperture in any denser material, the limiting angle being greater the denser the material; being 90° when the densities are equal.

* See vol. i. Plate VII. Professor Keith notifies the following errata in the lithographed computation:—

In the elements furnished by Mr. Tolles, $r - 0 \cdot 29$ should be $r - 0 \cdot 029$, and in the fourth columu of figures, seventeenth line from the top, 55° 5′ 51″ should be 55° 5′ 21″.

XVII.—*Note on Mr. Wenham's paper "On the Measurement of the Angle of Aperture of Objectives."* By Professor R. Keith.

(*Read 12th February*, 1879.)

Mr. Wenham, in a paper read November, 1878,* seems to apprehend the interference of outside light in the ordinary process of measuring angular aperture, but his attempt to explain this interference fails to show where his difficulty is. His figure has no meaning in connection with the subject, as the outside legs of the tripod will not after refraction come to the same point in the field of the Microscope that the central one does, and therefore have nothing to do with the measurement. They will, of course, after refraction fall far to the right and left of the centre, and have nothing to do with the aperture question. One point in the image corresponding to one point in the object, *and one only*, is to be considered in making the measurement for aperture. It is true that with the sector as ordinarily used, first one edge of a lamp flame is brought to the centre of the field, and then the other edge: but the few minutes of arc subtended by the flame are, strictly, to be subtracted from the reading of the sector, thus practically making one edge of the flame only the object of consideration.

Those interested will bear in mind that in measuring aperture with the sector, the lamp flame is placed far enough away to render the rays of light sensibly parallel. The Microscope tube is then inclined to the direction of the lamp flame, until the outside ray of the flame is bent along the axis to the centre of the field, and the sector read. The tube is then again inclined to the direction of the flame on the opposite side until the outside ray of the flame is again bent along the axis to the centre of the field, and the sector again read.

Half the difference of the readings gives practically the exact amount by which the ray of light is bent. The whole difference is under these circumstances the angular aperture, and if two lights be placed so that their directions will form that angle at the objective, both lights will be visible at the same time in the Microscope. Whether the lights give but a single ray or a large bundle of parallel rays, the result will be the same. Any allusion to outside rays as interfering in this simple process is therefore erroneous.

* Vol. i. p. 321.

XVIII.—*Reply to the foregoing Note.*

By F. H. Wenham, F.R.M.S.

(*Read* 9*th April*, 1879.)

As those who have been engaged in the aperture controversy have explained their meaning repeatedly, I quite agree with what I understand is the view of the Council, that it should now be closed till some new fact appears to elucidate the question.

Professor Keith's Note does not call for discussion, as the objections appear to arise from a misapprehension of the acting conditions of the sector measurement. The flame does not remain in the centre of the field of the eye-piece during the traverse, and there is no axial bisection; the least movement sideways causes the image of the lamp to leave the centre, and when at last the light margin divides the field, the half illumination is actually caused from the eclipse of the light by the edge of the eye-piece stop. The position of the distant flame can be seen with an "examining lens" over the eye-piece. The field is traversed by the beam of light; this successively intersects all the oblique pencils of the object-glass which afterwards enter together in proximity at the eye-piece at a very small angle of divergence.

The sector measurement fails to indicate true angles of aperture, and in order to prove this without theorizing, I described in my last paper a plain and unmistakable demonstration. I took a series of decisive angles of aperture by the "triangle" method, viz. from the focal distance up to a definite diameter of front lens; I then measured the angle from each of these restricted diameters or apertures by the sector, employed precisely in the ordinary manner, and tabulated the comparative results as "false apertures."

With this I am content to allow all personal controversy to remain at rest, as I consider that I have clearly proved that angle of aperture is usually measured greatly in excess, as angle of field.

NOTES AND MEMORANDA.

☞ It is intended in future numbers of the Journal to classify the Notes and Memoranda and Bibliography as shown below,* by which plan it is believed that the value of the Journal as a scientific record will be enhanced.

ZOOLOGY.

A. GENERAL, INCLUDING EMBRYOLOGY AND HISTOLOGY OF THE VERTEBRATA.

B. INVERTEBRATA.

For Bibliography only.
- (a) PROTOZOA.
- (b) PORIFERA.
- (c) CŒLENTERATA.
- (d) ECHINODERMATA.
- (e) VERMES.
- (f) ARTHROPODA.
  - (α) CRUSTACEA.
  - (β) ARACHNIDA.
  - (γ) MYRIAPODA.
  - (δ) INSECTA.†

- (g) MOLLUSCOIDA.
- (h) MOLLUSCA.

BOTANY.

A. GENERAL, INCLUDING EMBRYOLOGY AND HISTOLOGY OF THE PHANEROGAMIA.

B. CRYPTOGAMIA.

For Bibliography only.
- (a) ALGÆ.
- (b) LICHENES.
- (c) FUNGI.
- (d) CHARACEÆ.
- (e) MUSCINEÆ.
- (f) VASCULAR CRYPTOGAMS.

MICROSCOPY.

(Instrumental—Methods, Reagents, &c.)

ZOOLOGY.

A. GENERAL, INCLUDING EMBRYOLOGY AND HISTOLOGY OF THE VERTEBRATA.

Nuclei of the Blood-corpuscles of the Triton.—Urged by the publication of Stricker's researches, according to which the nuclei of

* We are aware that this classification is more or less open to criticism, but we have adopted it as being on the whole the most convenient for this particular purpose at least.

† It is not proposed to deal exhaustively with the Insects; that branch of the Animal Kingdom being already well provided both with journals and special societies.

the corpuscles are not constant structures, M. Pouchet has made some observations,* of which the following are the chief conclusions:—

(1) The red and white corpuscles are derived from the same anatomical elements. (2) The nuclei of the white corpuscles undergo complete segmentation, but (3) this segmentation does not occur so long as they are freely suspended and moving in the serum. (4) The red corpuscles are "final elementary forms." (5) The so-called reticulum in these corpuscles of the Triton is merely the result of the partial division of the substance of the nucleus. (6) In development these nuclei reach a certain maximum size, and then decrease. (7) The red blood-corpuscles themselves disappear by dissolution in the serum. (8) There is no fissiparous multiplication of red blood-corpuscles after that these bodies become provided with hæmoglobin. (9) As is well known, the red corpuscles may be discoid or ovoid in shape, and it is suggested that there is some relation between these two forms and the molecular state of the contained hæmoglobin. The nucleolus of the corpuscles is defined as being that point, or those points, which have a greater "elective affinity" for carmine. The paper is illustrated by a plate of sixteen figures.

Division of Cartilage Cells.—An important research on this subject is published by W. Schleicher,† whose results agree in the main with those of Flemming,‡ but differ in many points not wholly unimportant. Schleicher denies the presence of a true intranuclear network, but describes rods, fibres, and granules (Stäbchen, Fädchen, und Körner), as existing within the nucleus. The first step in the division of a cartilage cell consists in the disintegration of the nuclear membrane; next, the contents of the nucleus—the rods, &c., undergo an extraordinary series of changes of form and position, the whole nucleus at the same time constantly changing its position. After a time, the rods, &c., take on a more or less parallel arrangement, and then, becoming approximated at their extremities, form a more or less fusiform figure, corresponding to the spindle-nucleus of other observers. The approximated ends of the rods then fuse together, and division takes place along a plane taken through the centre, and perpendicular to the long axis of the spindle. The nuclei of the two daughter-cells are thus produced; each of these becomes resolved into rods and fibres, these undergo changes of form, and, at length, those situated towards the periphery of the nucleus curve round and fuse with one another, forming a new nuclear membrane. In the membraneless state of the nucleus a connection was observed between its fibres and those occurring in the protoplasm of the cell—the intracellular network of other authors. Some observations made tended to the opinion that the intracellular fibres arose, by a process of delamination, from the capsule of the cell.

Influence of the different Colours of the Spectrum on Animals.—The article of M. E. Yung, of which we gave an abstract (from

* Robin's 'Journ. Anat. et Phys.,' xv. (1879) 9.
† 'Archiv. f. Mikr. Anat.,' xvi. (1878) 245.
‡ This Journal, ii. (1879) 137.

'Comptes Rendus') at p. 138, has now been published in Professor Lacaze-Duthiers' 'Archives,'* where it occupies thirty-two pages.

B. INVERTEBRATA.

Formation, Fructification, and Division of the Animal Ovum.—This subject is treated of in two papers by Oscar Hertwig,† each illustrated by three plates. He works out very fully for Echinoderms, Worms, Cœlenterates and Molluscs, the important questions of the fate of the germinal vesicle, the formation of the "polar cells," the precise phenomena attending impregnation, and the mode of formation of the first cleavage-nucleus of the fertilized egg. His results are for the most part confirmatory of his former observations,‡ and are briefly as follows:—

Before impregnation, the germinal vesicle becomes profoundly altered; its membrane disappears, and itself assumes a spindle form, with the usual radiation of granules from its poles. It then approaches the periphery of the egg, and one end of it passes into a small prominence on the surface of the latter. The spindle then divides in the usual way, one part remaining in the egg proper, the other in the prominence, which now becomes separated off as the first polar cell. The same process is gone through once more, and another polar cell formed. The portion of the nucleus still left in the egg now undergoes a change, becoming converted into a rounded body—the female pronucleus—surrounded by radiating granules. At about this time, or somewhat before, fertilization takes place, usually a single spermatozoon making its way into the vitellus, whereupon its tail undergoes absorption and its head is converted into a body—the male pronucleus—closely resembling the female pronucleus. The two pronuclei travel towards one another, coalesce, and produce by this process of conjugation, the first cleavage-nucleus of the impregnated egg.

Digestion of Albuminoids by Invertebrata.—The researches of Dr. Fredericq have been directed to Annelids, a cestoid Worm, Molluscs, Ascidians, a Bryozoon, an Echinoderm, a Cœlenterate and some Sponges. He treats the digestive organs of the animal, if they are large enough to be isolated, with alcohol. If the animals are too small he places a considerable number of them entire in the alcohol, which coagulates the albuminoid bodies, sparing the ferments. The objects thus treated are dried and pulverized, and the powder should contain the ferments. To distinguish them, one part of the powder is infused in distilled water, another part in water acidulated with muriatic acid, and a third with water alkalized by carbonate of soda. A piece of fibrin placed in the different liquids, heated to 40°, indicates by its solution or resistance the presence or absence of ferments analogous to pepsine or thrypsine.

The general result was found to be that the transformation of aliments is effected in the Invertebrata by digestive ferments analogous to those of the Vertebrata.§

* Vol. vii. (1878) 251.
† 'Morphol. Jahrb.,' iv. (1878) 156 and 177.
‡ See Balfour, in 'Quart. Journ. Mikr. Sci.,' xviii. (1878).
§ 'Bull. Acad. Roy. Sci. Belg.,' xlvi. (1878); 'Rev. Internat. des Sci.,' iii. (1879) 80.

Eozoon Canadense.—Dr. Dawson, F.R.S., writing on Professor Möbius' recent treatise, says * that *Eozoon Canadense* has since the first announcement of its discovery by Logan in 1859, attracted much attention, and has been very thoroughly investigated and discussed, and at present its organic character is generally admitted. Still its claims are ever and anon disputed, and as fast as one opponent is disposed of, another appears. This is in great part due to the fact that so few scientific men are in a position fully to appreciate the evidence respecting it. Geologists and mineralogists look upon it with suspicion, partly on account of the great age and crystalline structure of the rocks in which it occurs, partly because it is associated with the protean and disputed mineral serpentine, which some regard as eruptive, some as metamorphic, some as pseudomorphic. The biologists on the other hand, even those who are somewhat familiar with foraminiferal organisms, are little acquainted with the appearance of these when mineralized with silicates, traversed with minute mineral veins, faulted, crushed and partly defaced, as is the case with most specimens of *Eozoon*. Nor are they willing to admit the possibility that these ancient organisms may have presented a much more generalized and less definite structure than their modern successors. Worse, perhaps, than all these, is the circumstance that dealers and injudicious amateurs have intervened, and have circulated specimens of *Eozoon* in which the structure is too imperfectly preserved to admit of its recognition, or even mere fragments of serpentinous limestone, without any structure whatever. He has seen in the collections of dealers and even in public museums, specimens labelled "*Eozoon Canadense*" which have as little claim to that designation as a chip of limestone has to be called a coral or a crinoid.

The memoir of Professor Möbius affords illustrations of some of these difficulties in the study of *Eozoon*. Professor Möbius is a zoologist, a good microscopist, fairly acquainted with modern foraminifera, and a conscientious observer: but he has had no means of knowing the geological relations and mode of occurrence of *Eozoon*, and he has had access merely to a limited number of specimens mineralized with serpentine. These he has elaborately studied, has made careful drawings of portions of their structures, and has described these with some degree of accuracy; and his memoir has been profusely illustrated with figures on a large scale. This, and the fact of the memoir appearing where it does (Palæontographica), convey the impression of an exhaustive study of the subject; and since the conclusion is adverse to the organic character of *Eozoon*, this paper may be expected, in the opinion of many not fully acquainted with the evidence, to be regarded as a final decision against its animal nature. Yet, however commendable the researches of Möbius may be, when viewed as the studies of a naturalist desirous of satisfying himself on the evidence of the material he may have at command, they furnish only another illustration of partial and imperfect investigation, quite unreliable as a verdict on the questions in hand.

Dr. Dawson then "indicates the weak points of the memoir," of which the following is a summary.

* 'Am. Jour. Sci. and Arts,' xvii. (1879) 196.

1. There are errors and omissions from want of study of the fossil *in situ*, and from want of acquaintance with its various states of preservation.

2. He confounds the finely tubulated proper wall of *Eozoon* with the chrysotile veins traversing many of the specimens and obviously more recent than the bodies whose fissures they fill.

3. In regard to the canal system, he thinks that the round and regularly branching forms which he figures, and which nearly resemble the similar parts of modern Foraminifera, are rather exceptional, which is a mistake.

4. A fatal defect in his mode of treatment is that he regards each of the structures separately, and does not sufficiently consider their cumulative force when taken together.

Reticularian Rhizopoda.—Mr. H. B. Brady, F.R.S., in notes on some of the Reticularian Rhizopoda of the 'Challenger' Expedition,* referring to Carpenter, Parker, and Jones's 'Introduction to the Study of the Foraminifera,' the work of Professor Reuss, and the more recent suggestions of Professor Zittel and Professor T. Rupert Jones, as to classification, says that it is not altogether satisfactory to have to depend solely upon the structure and conformation of the external skeleton or test for distinctive characters. There can scarcely be a doubt that the sarcode bodies of animals varying so much in their features must have important differences. The researches of R. Hertwig on the animal of *Miliola* and *Rotalia*,† and those of F. E. Schulze ‡ on *Polystomella* and *Lagena*, permit no longer the belief that the Reticularian Rhizopoda consist of mere masses of undifferentiated protoplasm, and a wide field of investigation is thereby opened, in which the employment of chemical reagents, in conjunction with the higher powers of the Microscope, may be expected to yield a harvest of hitherto unnoted facts. But for these methods of research the fresh, if not the living animal must be used; material long preserved in alcohol, as the 'Challenger' dredgings have necessarily been, furnishes only the knowledge derivable from the harder tissues, and the portions rendered permanent by inorganic constituents.

Protozoa of Northern Russia. — An elaborate paper on this subject, illustrated by two plates, by C. von Mereschkowsky, § gives the results, as far as Protozoa are concerned, of his two journeys to the White Sea, made in the summers of 1876 and 1877.

1. *Proposed new Family.*—Mereschkowsky proposes to form into the new family *Uvellina* those colonial monads the individuals of which are provided with one or more cilia, are devoid of a lorica, but sometimes enclosed in a common gelatinous investment, are not united into a branched colony, but form more or less spherical masses, and for the most part (*Anthophysa* is an exception) are free-swimming. They may, in the author's opinion, be taken as transition forms

* 'Quart. Journ. Micr. Sci.,' xix. (1879) 24.
† 'Jenaische Zeitschrift für Naturwiss.,' x. 42.
‡ 'Archiv für Mikr. Anat.,' xiii.
§ Ibid., xvi. (1879) 153.

between unicellular and multicellular animals, and indeed as representing permanent *Morulæ*. Multiplication takes place, in fact, by the separation of a monadiform cell and its division into 2, 4, 8, &c., masses, by a process exactly resembling the segmentation of the egg-cell in a Metazoon. *Polytoma uvella* is not included in this family, since the morula form is not permanent, but breaks up into separate individuals.

2. *New Genera.*—The following three genera are described as being new to science. *Merotricha* (*M. bacillata*), a regularly oval uniflagellate monad; *Urceolus* (*U. Alenizini*), another uniflagellate monad, with transparent collar-like œsophagus; and *Haeckelina** (*H. borealis*), a beautiful and highly interesting marine Moneron, which seems to bear much the same sort of relation to the *Tentaculifera* (*Acineta*, *Podophyra*, &c.), as *Protamœba* bears to *Amœba*, *Myxastrum* to the *Gregarinidæ* and *Protomonas* to the monads.† It consists of a globular colourless body, capable of very slight changes of form, devoid of vacuole or nucleus but containing various granules. Its surface is closely beset with a great number of very delicate stiff pseudopodia, standing out at right angles to its surface, and about equal in length to the diameter of the body. The body is seated on one end of a stem, the other extremity of which is attached to foreign bodies (algæ). The stem is long, slender, transparent, and solid, being quite devoid of an axial "muscle." Nothing is known of the reproduction of this interesting species.

3. *New Species.*—The author describes a large number of new species, which our space merely allows us to enumerate. They are *Cothurnia arcuata* (marine), *Vorticella pyrum* (do.), *Zoothamnium marinum* (do.), *Epistylis balanorum* (do.), *Tintinnus Ussowi* (do.), *Oxytricha Wrzesniowskii* (do.), *O. oculata* (do.), *Aspidisca Andreewi* (do.), *Balantidium* (?) *medusarum* (do.), *Glaucoma Wrzesniowskii* (fresh-water), *Holophrya Kessleri* (do.), *Podophyra* (*Acineta*) *conipes* (marine), *Dinophysis arctica* (do.), *Heteromita sulcata* (fresh-water), *H. cylindrica* (marine), *H. adunca* (do.), *Clathrulina Cienkowskii* (fresh-water), *Pleurophrys angulata* (do.), *Difflugia Solowetskii*, *Hyalodiscus Korotnewi* (marine), *Amœba minuta* (do.), *A. papillata* (fresh-water), *A. angulata* (do.), *A. Jelaginia* (do.), *A. emittens* (do.), *A. alveolata* (marine), *A. filifera* (do.), and *Protamœba Grimmi* (do.).

4. *Geographical Distribution of Infusoria.*—The author sums up his remarks on this question in the form of three propositions. He considers it well established, firstly, that the marine Infusorial fauna, being exposed, like any other animal fauna, to the influence of external conditions, is wholly different to that of fresh water. Secondly, that the infusorial (protozoic) faunæ of different seas, distinguished from one another by unlike conditions, are themselves different, and this difference is of the same character as that existing in any group of the higher animals. Thirdly, that the

* This name has been applied by Bessels to Sandahl's *Astrorhiza*. See 'Quart. Journ. Micr. Sci.,' xvi. 221.

† See the table on p. 677 of Huxley's 'Invertebrata,' giving the relations of the various genera of *Monera* to the groups of *Endoplastica*. The discovery of *Haeckelina* fills up an important gap in this scheme.

marine protozoic fauna differs far more in different seas than does the fresh-water protozoic fauna in different terrestrial regions.

Deep-sea Siphonophora.—The *Siphonophora* have always been held to be an exclusively surface group; it is therefore of great interest to find species of the sub-order occurring at great depths. Professor Studer of Bern gives an account * of two well-marked species brought up during the voyage of the corvette 'Gazelle,' from depths of 1500–2000 fathoms in the Atlantic Ocean. Both species belong to the genus *Rhizophysa*, and are named by Studer *R. conifera* and *R. inermis*. Full descriptions, illustrated by three plates, are given of both forms, as well as of some fragmentary specimens of other *Siphonophora* found at the same time.

Strange Anomaly among the Hydromedusæ.—In the 'Transactions of the Society of Naturalists of St. Petersburg,' † a new species of small naked-eyed Medusa, from the White Sea, is described, which Mereschkowsky has named *Bougainvillea paradoxa*, and which (with another species of the same genus) presents a strange anomaly pretty frequently observed amongst the normal individuals.

The adult animal does not much exceed 1 cm. in length, and its form is that of a bell slightly contracted at its aperture, with four radiating canals, each furnished at its extremity with a tuft of from three to seven tentacles and with a red ocellus. The deep red manubrium has from above the form of a cross, from each of the four ends of which starts a radiating canal. Round the mouth there is a circle of four tentacles dividing dichotomously into a great number of branches. It is remarkable that the ova are developed immediately on the surface of the manubrium, so that the latter when the ova have become converted into planulæ acquires a tuberculate aspect, caused by a great quantity of planulæ forming a layer covering its surface, with one of their ends projecting freely, and the other attached to the wall of the manubrium.

Some forms (undoubtedly of this same animal) are distinguished by the total absence of the coloured manubrium. It was thought that there might be some atrophy of the organ, but remains of it were sought for in vain. The whole gastro-vascular system consisted only of a circular canal and of the four radial canals, which were united at the summit without forming anything resembling a stomach. Moreover, although in other respects of normal conformation, it had absolutely no opening to the exterior, no buccal or other aperture which might establish a communication with the circumambient water.

This fact is the stranger because these anomalies are observed in Medusæ which are but very little exceeded in size by the normal adult individuals. They consequently have been able to nourish themselves, since from microscopic embryos they have attained a size of more than half a centimetre.

M. Mereschkowsky considers that the only probable hypothesis to account for the development of a complete Medusa, without the aid

* 'Zeitschrift f. wiss. Zool.,' xxxi. (1878) 1.

† 'Protocolles de la Réunion du 14 Jan. 1878,' ix. 33.

of organs of nutrition, is that the ectoderm fulfils the function of the entoderm, and the animal nourishes itself by its ectoderm absorbing the organic material dissolved in sea water, a supposition the more probable as he has already demonstrated the same fact in sponges.*

Muscle-epithelium in Anthozoa.—Dr. O. Kling publishes a preliminary communication on this subject,† in which he studies the exact relation of the so-called neuro-muscle cells in the genera *Actinozoa*, namely *Actinia* (*equina*) and *Muricia*. In both these genera he finds that the muscular layer occurs on the inner (endodermal) side of the supporting lamella, and that the cells of which it is composed are in evident connection with the endodermal cells.

The arrangement in these forms is therefore the exact opposite to those which obtain in *Hydra*, in which, as Kleinenberg showed, the neuro-muscular cells are undoubtedly ectodermal. This seems to show that the mesoderm, like the generative products, may have originally sprung indifferently from either layer.

Phylogeny of the Antipatharia.—This subject is discussed in a paper‡ by G. v. Koch, who begins with a description of *Antipathes larix* and *Gephyra Dohrnii*, and afterwards discusses the probable steps in the evolution of the *Antipatharia*, which he considers to have been as follows:—

1. Soft-bodied *Actiniæ* secreted a horny substance from the ectoderm of the disk of attachment.
2. Those of the foregoing forms, which were attached to thin cylindrical supports, surrounded the latter and covered them with a horny substance, which, in the case of polypes occurring in large groups, served to unite them by their bases.
3. These polypes, living singly or in groups, became united, by means of stolons, into a colony. The axial skeleton no longer existed exclusively as an investment to some support, but gave off independent branches.
4. The separate parts of the polypes underwent retrogression.
5. The colonies (zoanthodemes) assumed a greater independence of form, while the axial skeleton no longer retained the form of an investment of a foreign support. The polypes decreased in size concomitantly with the increase of their numbers on one colony; with this diminution in size was connected arrest of the mesenteries and tentacles.

Skeleton of the Alcyonaria.—A study of this interesting group of *Actinozoa* has been made by v. Koch.§ In the first part of the paper the author gives a description of the anatomical character of the following genera and species:—*Sclerogonia Mexicana*, *Mopsea erythræa*, *Melithæa*, *Muricea placomus*, *Isis elongata*, *Primnoa verticillaris*, *Pennatula rubra*, *Halisceptrum Gustavianum*, and *Kophobelemnon Leuckartii*.

The second part is occupied with a description of the skeleton of

* 'Ann. and Mag. of Nat. Hist.,' iii. (1879) 177.
† 'Morphol. Jahrb.,' iv. (1878) 327.
‡ Ibid., iv. (1878) 74. § Ibid., iv. (1878) 447.

Alcyonaria, and begins with a brief general description of the skeleton of *Actinozoa*. This may occur in either of the following positions:—

1. On the free (inner) surface of the entoderm 2. Within the entoderm	Entoskeleton.
3. Between the entoderm and ectoderm— *a*. Secreted from entoderm cells only .. *b*. From both layers .. .. *c*. From ectoderm cells only	Mesoskeleton.
4. Within the ectoderm .. .. 5. On the free (outer) surface of the ectoderm	Ectoskeleton.

Of these only the third and fifth kinds occur in *Alcyonaria*.

The mesoskeleton in the simple forms consists of "a thinner or thicker layer between the ectoderm and entoderm, which, after removal of all the cellular elements of the body, retains the form of the polype, since it extends between all the folds of the two primary cell-layers."

In those compound forms which have the polypes connected by stolons, the mesoskeleton exists in the form of a thin lamella between the two layers of the stolons. In the species in which the polypes are united into a broad plate-like colony by means of a solid mass or cœnenchyma, the greater part of the latter is formed by the mesoskeleton, which is covered externally by ectoderm, while within are contained the nutritive canals, lined with entoderm, by means of which the polypes are placed in communication with one another.

In a few forms, the mesoskeleton consists merely of a hyaline or fibrillar substance (*Monoxenia*, *Cornularia*). In other cases calcifications or spicules are developed, the arrangement of which differs greatly, both in various portions of the same polype or of the same zoanthodeme, and in the various genera and species. The spicules are often scattered singly in the hyaline matrix, but often, on the other hand, exist in such great numbers as to give the whole skeleton a firm, cork-like consistency, its form being then but slightly altered by drying. In many cases the separate spicules undergo fusion, and form a firm continuous framework, which may replace, to a greater or less extent, the hyaline matrix (*Tubipora*, *Pseudaxonia*). In a few forms there is a continuous mesoskeleton, not due to the fusion of originally distinct calcifications. The free part of the polypes and the peripheral portions of the zoanthodeme never undergo conversion into horn, but only the so-called axis (pseudaxis, Koch). Calcification of the horny interstitial substance has not been made out in *Alcyonaria*.

An ectoskeleton occurs only in the tree-like zoanthodeme, and probably also in *Pennatulidæ*. As far as is known, it consists of a secretion of the ectoderm cells of the attached surface; this secretion increasing with the growth of the colony, forms a horny more or less calcified axis (the sclerobase). Frequently cavities occur in the horny substance, filled either with a spongy material (*Gorgonia*, *Muricea*), or by a crystalline substance, rich in calcific matter (*Plexaurella*). Often there is an alternation of horny and calcareous lamellæ, and in many species the whole axis is formed of alternate horny and calcareous pieces. On the other hand, the horny substance may be uniformly impregnated with calcic carbonate, but spicules never occur in the ectoskeleton. The central part of the axis may remain empty

or be filled up with spongy tissue traversed by cross-partitions; secondary, calcific masses may also be found in the cavities of the axis.

The third part of the paper is classificatory: the author divides the various families of the *Alcyonaria* into three chief groups, as follows:—

I.—Polypes never united into a colony.
Fam. 1. *Haimeida.*

II.—Colonies are formed, but the individual polypes remain independent, and are only united by stolons or by plate-like expansions.
Fam. 2. *Cornularida.*—Spicules separate.
„ 3. *Tubiporida.*—Spicules united into a continuous skeleton.

III.—The cœnenchyma is well developed, and the polypes appear only as organs of the colony.
a. Mesoskeleton only developed.
Fam. 4. *Alcyonida.*—Skeleton spicular.
„ 5. *Pseudaxonia.*—Skeleton continuous.
„ 6. *Helisporida.*—Main part of skeleton calcified; no spicules.
b. Both meso- and ectoskeleton developed.
Fam. 7. *Pennatulida.*—Free-swimming; digestive cavities long.
„ 8. *Axifera.*—Fixed; digestive cavities short.

New Species of Isis.—A new species—*Isis Neapolitana*—of the interesting Alcyonarian order *Isidaceæ* has been recently discovered by v. Koch, who gives an account of its anatomy,* together with the following diagnosis:—

"Polypary about 1 metre high, ramified, attached to rocks, &c. by means of an irregularly lobed basal plate, branches springing from the horny internodes. Calcareous joints of the axial skeleton white, cylindrical; on the thicker stems about 8 mm.; on thinner branches about 16 mm. long, strongly ribbed. Internodes dark brown, becoming shortened with the decrease in thickness of the stem, from 2·5 mm. to 0·3 mm. in length. Cœnenchyma thin, greyish-white, containing calcareous spicules only in the bases of the polypes. Nutrient canals twice as numerous as the longitudinal grooves on the calcareous joints. Polypes scattered over the branches, about 3 mm. long, well provided with smaller and larger spicules; outer wall of tentacles also containing spicules. Polypes very slightly contractile. Habitat, Gulf of Naples.

The paper is accompanied by a plate, illustrating the anatomy of the species.

Gorgonia verrucosa.—In a short paper on the anatomy of this species,† v. Koch records the important discovery of a layer of epithelial cells between the horny axis of the zoanthodeme and the cœnenchyma. He has found the same thing in other *Gorgoniæ*, and considers it certain that, in some at least of the horny corals, the axial skeleton is a secretion of an epithelium derived, in all probability, from the ectoderm.

This discovery is of great interest, as, according to most observers, the axial skeleton of *Gorgonidæ* is formed from the connective tissue of the cœnenchyma; Koch himself, indeed, assigns this origin to it in *Isis.*

* 'Morphol. Jahrb.,' iv. (1878) 112.

† Ibid., 269.

Prehensive Cells in the Ctenophora.—Dr. Carl Chun gives * an account of his observations on certain prehensive cells which have been observed in the *Ctenophora;* those which are found on the "grappling lines" of these forms were principally studied in *Cydippe hormiphora*, Gegbr. The bodies in question were but $\frac{1}{100}$ of a millimetre in breadth, and were chiefly made up of gelatinous tissue, just as is the greater part of the body of these Cœlentera; they contain a filament, coiled into five or seven spires, which, when fully extended, has much the form of *Vorticella;* nor does the resemblance end here, for the thread may be seen to be provided with a muscular band, the functions of which are examined. The author corrects some of Clark's observations on these so-called "Lasso-cells," and, pointing out that they are not, like the ordinary thread-cells, set free from a containing cell, thanks to their elasticity, proposes to call them "Greif-zellen." He adds that he has failed to find true stinging-cells (nematocysts) in the Ctenophora, and urges that they cannot be regarded as belonging to the Nematophorous group.

Australian Corals.—The Rev. J. E. Tenison-Woods, in the 'Proceedings of the Linnean Society of New South Wales,' † says that a study of the Australian living forms has shown that some of the fossil species thought to be extinct are still existing. They are *Trochocyathus Victoriæ* and *Sphenotrochus variolaris.* There are also forms which have a remarkable relation with extinct species, viz. *Conocyathus Zelandiæ*, which was not known as Australian, and which bears a strong resemblance to the extinct European Miocene form *C. sulcatus.* It would bo almost useless to form any conclusions from the very few observations which have resulted in the discovery of a few new species, yet what has been discovered shows plainly what might be expected from an extended series of operations. So far as has been learned, the coral fauna of New Zealand is very distinct from the Australian. If the observations of Quoy and Gaimard are to be relied upon, the northern end of New Zealand possesses forms which are never found out of the tropics in Australia, and very far within the tropics as well—*Porites Gaimardii* and *Polyphyllia pelvis.* Among the simple corals *C. Zelandiæ* is the only form known as common to both Australia and New Zealand.

The only corals on the S. and S.E. coast of Australia which could in any sense be called reef-building forms are one or two species of *Stylaster* and one or two of *Plesiastræa.* Both of these are littoral and grow in tufts or small masses, but never in anything more than the merest patches.

Eleven new species are described and figured, for two of which the author has erected two new genera. One, *Dunocyathus (parasiticus)*, is a parasitic coral of minute size, growing on the base of the singular Polyzoary named by Professor Busk *Lunulites cancellata*; the other, *Crispatotrochus (inornatus)*, a form which approximates to *Ceratotrochus*, but differs in the absence of any special ornamentation on the

* 'Zool. Anzeiger,' i. (1878) 50.

† Vol. ii. (1878) 292: "Extratropical Corals of Australia."

ribs and the wide, deep calice, with a large hispid and spongy columella and a broad attachment.

Amongst the new species the author has been able to add one to each of the remarkable and rare genera *Endopachys* (*Australiæ*), and *Heteropsammia* (*elliptica*). The author also in other papers describes a new species of *Psammoseris*—*P. cylicioides*,* —and of *Desmophyllum*—*D. quinarium*, †—the former with a plate of eight figures.

New Genus of Milleporidæ.—In the same publication the Rev. J. E. Tenison-Woods describes ‡ a new genus of Milleporidæ, *Arachnopora*, the generic character being "zoothome parasitic spreading like a small thin web over other corals." In the only species found (*A. argentea*) the substance of the zoothome (7 by 3 mm.) seems a quite transparent membrane, on which there is generally a very close arrangement of small silvery granules. It occurs parasitic on corals, filling up half of the calice and spreading from opposite septa like a spider's web. It also spreads over the sides of the costæ, where it appears just like a snail's track, on which some very fine white dust had been sparsely scattered. There are no calices on the outside.

New Genus of Starfishes.—Dr. J. Jullien describes § a new genus *Marthasterias* allied to *Asterias*, and characterized by its four rows of ambulacral tubes, the reticulated character of the dorsal skeleton, five arms, the presence of spines in the membrane edging the marginal plates, and its pedunculated pedicellariæ: to the new species the name *foliacea* is given.

Some idea of its characters will be gathered from the fact that "an eminent zoologist" regarded it as an *Asterias glacialis* which had undergone violent compression; this theory is, however, negatived by the presence on the dorsal surface of fragments of *Retepora cellulosa*, which would not have been preserved had the animal undergone the accident suggested. The rows of ambulacral spines are moreover single, and not double as in *Asterias;* while the spines themselves are simply conical, and are without the median constriction observed in that common form. The habitat of the single specimen described is not quite certainly known, but it is stated to be the Adriatic; the presence of a young *Nassa reticulata* in its intestines, together with that of the above-mentioned bryozoan on its surface, seems to indicate sufficiently clearly that it is an inhabitant of some European sea.

Helminthology.—Linstow continues, in the 'Archiv für Naturgeschichte,' ‖ his observations on Helminthology; the paper is purely technical, but it may be of interest to observe that this indefatigable observer here describes forty-two forms, of which twenty-four are new species. The last described is the curious *Sphærularia bombi*, Dufour, and the author states that he has found in the roots of moss a Nematode form, which is very like it, though somewhat larger, and

* 'Proc. Linnean Soc. N. S. Wales,' iii. (1878) 8.
† Ibid., 17. ‡ Ibid., 6.
§ 'Bull. Soc. Zool. de France,' iii. (1878) 141.
‖ xliv. (1878) 218.

with a thicker caudal region. In the genus *Ascaris* there are two series of larval forms, one with and one without a boring denticle; of the former series the larvæ of *A. capsularia*, *A. eperlani*, and *A. communis* are of a relatively enormous size. The paper is illustrated by three plates.

Excretory Apparatus of Solenophorus megalocephalus. — M. J. Poirier* having some Solenophora, which had only remained a short time in alcohol, injected their excretory apparatus, and on examining the result saw that it did not agree with what had been hitherto published.

Instead of two longitudinal vessels on each side of the segments (the mode of communication between them not having been hitherto noticed), M. Poirier found, as in *Duthiersia*, six such vessels. The two internal ones alone communicate with each other by transverse canals, situated, as in all the Cestoids, at the commencement of each segment. These vessels, which (with the exception of the internal ones) have in the segments no direct communication with each other, in the scolex form a network which unites them. The external vessel, when it reaches the scolex, buries itself more deeply, passing under the two others and going along the groove which separates the two bothridia, towards the extremity of the scolex; there it divides into two branches, which ramify in each bothridium. The median vessel, of a smaller calibre than that of the two others, passes above the external vessel, and about the middle of the length of the scolex bifurcates into two branches which unite to the network formed by the divided branches of the external vessel.

The internal vessel bifurcates immediately after its entrance into the head, and forms a network of very large meshes which is joined to the network of smaller meshes arising from the external vessel. These three pairs of vessels therefore only form one system.

Besides the above vessels, which are of a considerable size, we find on the surface of the body, a second system of fine vessels, which M. Blanchard pointed out some time ago in the Tæniæ as a circulatory apparatus, and whose existence Gegenbauer denies altogether in his 'Comparative Anatomy.' These vessels, which are very fine, form on the surface of the segments and of the scolex a network of rectangular meshes, much closer in the Solenophora than in the Tæniæ, in which the longitudinal vessels of this network are few in number, as M. Blanchard has shown in *Tænia solium*, and as M. Poirier has proved in *T. crassicollis* of the cat. This network is only interrupted around the genital orifices: according to M. Blanchard it is completely isolated, but in reality communicates with the preceding system. Indeed, in the posterior part of each segment, the external vessel of the first system sends out a branch as far as the edge of the segment, and there produces ramifications which go into the external longitudinal vessels of the second system. The other vessels of the first system have no communication with these fine peripheral vessels; but, as they reunite in the scolex with the external vessel, it follows

* 'Comptes Rendus,' lxxxvii. (1878) 1043.

that the two systems communicate and only form one single apparatus.

The fine peripheral vessels communicate by very fine and very short vessels with the calcareous corpuscles scattered over the surface of the body.

The apparatus must therefore be an excretory apparatus. It might perhaps also serve as an organ of absorption and nutrition, the fine peripheral vessels conducting the absorbed products into the large vessels, which would distribute them into the deeper parts of the organism.

Anatomy and Embryogeny of the Tæniadæ.—A preliminary communication on this subject by M. Monier * is chiefly a revision or criticism of the results of Sommer on *T. mediocanellata* and *T. solium;* the author justly observes that the excellent work of the German helminthologist seemed to be one which would be for a long time accepted as classical. The mother-cells of the spermatozoids are formed in the midst of a mass of central tissue, and there are no proper seminal ducts through which they may escape; this explains why they are provided with that long and apparently useless flagellum. What seminal tubes there are, are formed by a kind of excretion around the bundles of spermatozoids, and do not ordinarily become easily visible, except when, as in *T. cerebralis*, they are pigmented. In some species there appear to be two sets of spermatozoids, which become mature at different periods. The uterus does not receive the ova, which are formed in just the same place and in just the same way as the spermatozoids.

The *Hauptdotter* and *Nebendotter* of Sommer are stated to be merely extended ectodermal masses, one of which—the former—sometimes forms a kind of envelope for the egg. The so-called circular muscular layer is, in the young, found to give off fibres to the interior and to the exterior; these fibres are separated peripherally and unite at their centre to form the "parenchyma"; where they join the cuticle they form a very dense layer. Further observations are promised.

Parasites of the Lamellibranchiata.—Ulicny † gives an account of some observations on these parasites.

In *Cyclas rivicola* he finds a form of which little seems to be known, although it appears to be the *Cercaria Cycladis rivicolæ* of Diesing. These forms, which were found in sporocysts, imbedded in the generative organs of their host, were, thanks to their tail, capable of a large amount of movement; they are provided with a terminal oval sucker, above which there is a spine; in the anterior part of the last third of the body is placed the ventral sucker, which is as broad as the body. The most interesting region is the terminal or caudal portion. Connected by a narrow stalk with the end of the body there is a pyriform bulb, the surface of which is thrown into a number of folds; the interior of this enlargement is filled with a thick fluid, in which small vacuoles may be frequently observed, and

* 'Rev. Internat. des Sci.,' ii. (1878) 689.
† 'Arch. für Naturgeschichte,' xliv. (1878) 211.

it is also enclosed in a still larger bladder; the walls of this investment are invaginated at the anterior end, so as to form an aperture through which the body of the Cercaria can be protruded; on the other hand, the whole of the creature may be at times observed to be retracted within this envelope. With regard to this last no explanation is offered, but it is noted as non-existent in *Cercaria macrocerca*, although the tail of this form has a proper investment.

The author makes some observations on the species of *Bucephalus* which infest members of the same division of the Mollusca; two forms, *B. polymorphus*, Baer, which lives in the reproductive organs of Anodon, and *B. laimeanus*, Lacaze-Duthiers, which is found in marine forms, *Cardium* and *Ostrea*, are already known; a third, which as standing between the other two is very appropriately named *B. intermedius*, is now described; it was found in *Anodonta cellensis*, and the peculiarities of its structure are associated with its caudal region. In *B. polymorphus* the body terminates in a compressed and more or less biscuit-shaped bulbous enlargement, the broad end of which is attached to the body of the worm; the tail connected with this bulb, in which, it should be said, two portions can be made out, is eminently variable in form owing to its great power of contractility; in the new species the two parts are more distinctly differentiated and are separated by a constriction, but the caudal portion is constantly cylindrical in shape, and its only power of change is limited to its greater or less extension. When several forms get together they are able to form, with their tails, a veritable Gordian knot, which no instrument can unloose; in this point it differs very markedly from *B. polymorphus*, the tail of which can by very slight excitation be brought to change its form.

New Turbellarian.—The sojourn of Mereschkowsky on the White Sea has at any rate produced an account of a most interesting Turbellarian, to which he has given the name of *Alauretta viridirostrum*.* The body of this creature was elongated, and broadest at its anterior end, and measured $\frac{8}{10}$ of a millimetre; all but the proboscis, which was green, was colourless, and fairly transparent. Seen from without there appear to be three segments, owing to the presence of two circular constrictions towards the posterior end. By the aid of fine short cilia the animal moves about rapidly; these cilia are found over the whole body, with the exception of the very anterior region, where a single seta on either side stands directed forwards and outwards. The integument is thick and is succeeded by two layers of the body wall; of these the inner one is the thicker, and is distinguished by giving off five projections into the body cavity, which give an appearance of metamerism, and to which the author gives at least their full weight.

The mouth is placed in the anterior part of the body, where it forms an ellipse-shaped cleft; the enteric tube is straight, and does not branch; the position of the anus is left in a little doubt. The nervous system is distinguished from that of all other Turbellaria, by the possession of a large number of bipolar and unipolar nerve-cells; the eyes are on either side of the nerve-centre.

* 'Arch. für Naturgeschichte,' xlv. (1879) 35.

The apparent segmentation of the form leads the author to inquire as to the possibility of his having had to do with a larval Annelid; all these forms, however, seem to agree in that they do not exhibit metameric segmentation till a late period, and at any rate not until they have developed setæ at points corresponding to, and apparently indicative of such segments; while the presence of sexual products in the forms observed militates against their being immature. Nor again does the metamerism seem to be due to gemmation, nor is it the first instance of such an arrangement; Busch recorded a case in 1851, the characters of which were in 1865 put by Metschnikoff in their true light, while the Russian naturalist took this opportunity of recording another example. The form appears to belong to the *Microstomeæ*.

The most interesting points in a new species of *Prostomium* (*P. boreale*) are the presence of a chitinous sabre-shaped spine, which is placed to one side of the penis, and appears to be an organ either of defence or offence, and of a collection of glandular bodies of uncertain function, set on either side of the base of the proboscis. In another new species (*P. papillatum*) Mereschkowsky observed the presence of six papilliform projections at the anterior end of the body, which serve undoubtedly as tactile organs.

In a new species of *Mesostomium*, which he dedicates to L. Graff, Mereschkowsky describes the presence of enlargements on the vessels, which did not however exhibit either contraction or pulsation, and the function of which remains obscure; they do not seem to have been hitherto observed in these forms.

The author also makes some remarks on *Dinophilus vorticoides*, Oscar Schmidt, and on the general Turbellaria-Fauna of the White Sea.

Digestive Organs of the Fresh-water Turbellarians. — Elias Metschnikoff, who in 1866 was able to confirm the results of Claparède, made three years earlier, as to the absence of an alimentary canal in some of the Rhabdocœlous Planarians, returns to the subject,* and points out that the results, which have been denied by Minot on à priori grounds, have been confirmed by Uljanin (1870), Salensky (1872), and much more lately by Graff. He further proceeds to consider how far this character is one that is peculiar to these forms, and which so impressed Uljanin as to lead him to give to them the name of *Acœla*, or whether it is not rather one that is essentially common to the whole of the Turbellaria.

His account of the modes of digestion in a fresh-water Turbellarian allied to *Mesostomium productum*, and in *M. Ehrenbergii*, is peculiarly interesting. The former presented a fairly irregularly arranged mass of digestive cells; in these cells he found not only urinary concretions, but other bodies which he feels compelled to regard as nutrient particles; in *M. Ehrenbergii*, which is transparent, he was able to trace the history of these particles more completely. The chief food of this worm is *Nais proboscidea*, and an hour after ingestion he was able to discover all the soft parts of the *Nais* in its enteric cells; the cuticle and its setæ alone remained in the lumen of the tube. To

* 'Zool. Anzeiger,' i. (1878) 387.

test the matter still more accurately he attempted to feed the *Mesostomium* with carmine, but in this he failed; the *Nais* was however less refractory, and he thus succeeded in getting some very distinct points of observation so soon as the prey had been devoured by the Turbellarian.

Two species of Planarians were fed with blood, and the corpuscles were soon observed in the cells of their enteric tube. From these observations only one conclusion is possible: there are Turbellaria which are either without any differentiated digestive system, or which have retained the primitive method of digestion, that namely of taking the nutrient particles into their enteric cells. On the other hand it is no less certain that there are forms in this group which have passed beyond this stage, and do not allow the nutriment to pass into the epithelial cells of the enteric canal until they have been subjected to the ordinary digestive process. These observations are, it should be observed, of great importance as affording an example of the like of which we cannot, in the present state of the evolution question, have too many; for it bears directly on that variation in function of parts morphologically the same, which must have occurred if the theory of evolution be a correct explanation of morphological facts.

Land Planarians.—Dr. Kennel states in the 'Zoologischer Anzeiger,'* the results of his observations on *Fasciola terrestris*, O. F. M., and *Geodesmus bilineatus*, Metschnikoff, the two forms of Land Planarians found in Germany. He was fortunate enough to be able to get a specimen of the former which produced young whilst under observation, and he notes that these are almost completely white. His study of the generative organs leads him to pretty much the same results as did those of Moseley (on *Rhynchodemus*). The two ovaries are small rounded capsules, placed very near the anterior end of the body; of the testes there are from 22 to 24 pairs, set close together, and placed just behind the ovaries. The common efferent duct is to be found in the last third of the body, and on the ventral surface it leads into the narrow canal to which Minot has given the name of generative antrum; the vagina passes back from it and ends as a closed sac, but at the closed end there open into it on either side the oviducts; the uterus, which has also the form of a closed sac, opens into the vagina; the sheath for the penis is pear-shaped, and the well-developed penis is conical in shape.

The primitive vascular system of Moseley is regarded as forming the longitudinal nerves, and is said to be connected with a well-developed bilobed cerebrum.

Geodesmus has but a single pair of testes, and there is no cæcal sac on the vagina; the anterior end is not flat (Metschnikoff), but is deeply excavated on its ventral surface.

Marine Planarians.—Professor Goette gives in the same Journal † a short account of his observations on the development of Marine Planarians. He finds that in the freshly laid eggs of *Planaria*

* 'Zool. Anzeiger,' i. (1878) 26. † Ibid., 75.

Neapolitana the extrusion of two germinal vesicles precedes the segmentation of the yolk; this gives rise to four pear-shaped parts of equal size, which divide towards their narrower end into four ectodermal and four endodermal cells; the latter are at first the larger, but the ectodermal cells increase rapidly in size and form a cap over the others. The endodermal cells, as they multiply, become arranged in two rows, and gradually separate so as to form a cavity. The embryo is convex on its dorsal surface, and there is a median groove on the ventral; the whole larva is covered by cilia, of which there is a large tuft just in front of the eyes, and a smaller one at the hinder end. The animal at this stage has consequently very much the appearance of a *Pilidium*.

Goette, from the fact that there are certain Nemertines which cast their larval integument, like *Pilidium*, without having the form of this larva, and that there are *Dendrocœla* which pass through a *Pilidium* stage without undergoing any true metamorphosis, concludes that there are various modifications of this relatively simple process of development, and that the developmental history of the Nemertines may be referred to that of the *Dendrocœla*.

Organization and Development of the Oxyurids.—Dr. Osman Galeb made a communication last year to the French Association for the Advancement of Science on the Oxyurids found as parasites in insects, which is now published in Professor Lacaze-Duthiers' 'Archives.'* Dr. Galeb has found different species of parasites in different species of insects, notwithstanding the similarity of habit in the hosts, and he draws more particular attention to the mode of development, and to the genetic affinities of these parasitic forms.

The ova are easily studied owing to their great transparency; the germinal vesicle was not found to disappear at the period of segmentation, but to elongate and divide; and indeed it is not till after its segmentation that the egg begins to undergo the same process. The enteric tube is formed by two swellings, which gradually meet one another; the more anterior forms the œsophagus and the commencement of the intestine. The observations of the author on the development of the generative organs do not agree with those of Schneider; his later observations lead to the conclusion that these parts are formed by the proliferation of a cell in the abdominal region, and not by the division of the primitive cells into a central (ovarian) and a peripheral (investing and supporting) series.

M. Galeb believes that as the various species of *Orthoptera* and *Coleoptera* which he has studied have become differentiated from a parent form, the parasite of that parent form has likewise become differentiated into different species adapted to their varying hosts. With regard to these observations it may be interesting to draw attention to the fact that Mr. A. H. Garrod, the Prosector of the Zoological Society, has found a species of *Tænia* in the Rhinoceros from the Sonderbunds, which he regards as identical with the species of this parasite found by Professor Peters of Berlin and Mr. Garrod's

* 'Arch. Zool. Exp. and Gén.,' v. (1878).

predecessor in his office, Dr. Murie, in two quite distinct species of Rhinoceros.*

Researches on Bonellia viridis.—This interesting Gephyrean genus has been studied by F. Vejdovsky, who gives an account of the mode of formation of the eggs in the female, and of the organization of the male.†

1. *Formation of the Ova.*—The ovary is attached to a sort of peritoneal fold, and at its least developed end shows small accumulations of similar cells. Of these ova one, enlarging at the expense of the others, becomes the egg-cell; the sister-cells, or follicular cells, being gradually compressed and flattened until they form a mere secondary membrane to the egg, external to the vitelline membrane. Some of the sister-cells, however, do not take on the character of a follicular epithelium, but form a hollow cap over one pole of the egg, outside the follicle; these also gradually dwindle away as their substance is absorbed by the rapidly developing egg-cell, until finally they vanish altogether.

2. *Structure of the Male.*—The curious parasitic Turbellarium-like male of *Bonellia*, discovered by Kowalewsky, was found by Vejdovsky in the œsophagus of young females, as well as in the oviduct of sexually perfect females, and in the mud in which these live. It is a minute elongated creature, covered with a ciliated cuticle, and having a straight, widish alimentary canal opening by a mouth near the anterior end of the body, and contained in a body cavity; there is also an indistinct non-ganglionated ventral nerve-cord. The spermatozoa are formed from cells detached, as rounded aggregations, like those from which the eggs are produced, from the peritoneal membrane lining the body cavity. The spermatozoa pass by a ciliated funnel into a spacious vesicula seminalis, which lies on the dorsal side of the alimentary canal, and opens by an aperture at the anterior end of the body. The male excretory apparatus thus closely resembles that of the female, in which there is a ciliated funnel leading by a duct into a uterus in which the eggs are stored, and which opens externally by an oviduct. In both sexes, also, there is a pair of chitinous hooks in relation with the genital aperture: these were discovered in the male by Marion, who contributes a woodcut illustrating their position to Vejdovsky's paper, which is further accompanied by a plate.

The male of *Bonellia* is also treated of in a short paper by Selenka,‡ whose account differs in certain important respects from that given above. He denies the presence of a cuticle, and states that the external layer of the body is covered by ordinary ciliated cells. He denies also the presence of both mouth and anus, and describes the nervous system as possessing a distinct subœsophageal ganglion and circum-œsophageal ring. The animal also possesses, according to Selenka, a pair of segmental organs in the hinder third of the body. He remarks, in conclusion, upon the interest of *Bonellia* as affording one of the few cases of polyandry known in the animal kingdom; four to twelve or even twenty males being found in a single female.

* 'Proc. Zool. Soc.,' Nov. 1877.
† 'Zeitschr. f. wiss. Zool.,' xxx. (1879) 487.
‡ 'Zool. Anzeiger,' i. (1878) 120.

Development of Chætopoda.—The development of two species of *Serpula* (*S. uncinata* and *S. glomerata*) has been studied by Michael Stossich,* who sums up the results of his investigations as follows:—

1. The eggs of tube-worms undergo complete yolk-division.

2. From the blastula a gastrula is formed by invagination: the so-called blastopore passes directly into the permanent anus.

3. The cleavage cavity (blastocele) is filled with an albuminous or fatty fluid, exuded from the blastoderm-cells, which serves the purpose of a food-yolk.

4. The inner wall of the alimentary canal and the surface of the free-swimming larva are covered with cilia.

5. On the inner surface of the digestive canal are found two duplicatures marking the boundaries between œsophagus, stomach, and intestine.

6. The cleavage cavity undergoes conversion directly into the body cavity, in which, probably, at a later period, the mesoderm cells arise.

7. Above the anal aperture a vesicle (?) is formed, which is connected with the formation of the muscular system.

8. Underneath this "anal vesicle" the larvæ develop, at the end of the body, a tongue-shaped mass, by means of which they attach themselves to foreign bodies.

Parasitism of Notommata on Vaucheria.—R. Wollny, of Niederlössnitz, has made some recent observations on the mode in which this Rotifer is developed within the Vaucheria-cell.† The Vaucheria in which the development takes place is so weakened as to be unable to produce the reproductive organs; the part in which the ova are found being modified for the purpose of forming the swellings or galls within which the rotifer is developed from the ovum. The ova have the tendency to force themselves into the Vaucheria-tube through the canal which unites the gall to the tube, and do not escape directly from the gall. The tube either then decays in consequence of being deprived of nutriment, or the young rotifer forces its way through it. In a Vaucheria obtained from Rome, Wollny detected also galls of a slightly different character; but he had no opportunity of examining either the ova of the parasite or the perfect animal.

Kidney of the Fresh-water Crayfish.—An investigation on the curious "green-gland" of the Crayfish has been lately made by C. E. Wassiliew,‡ whose observations form an important contribution to our knowledge of that organ. He states that the gland consists of a single unbroken coiled tube, blind at one end, opening at the other into the sac of the gland or urinary bladder, and consisting of three distinct portions. The first of these has the form of a somewhat triangular yellowish-brown lobule, lying on the upper surface of the gland and forming the blind terminal portion of the whole tube; the second forms a green cake-shaped mass, constituting the lateral and inferior parts of the gland; while the third is a long, white, coiled

* 'Wiener Sitzungsb.,' lxxvii. (1878) 1 Abth. 533.
† 'Hedwigia,' xvii. (1878) 5 and 97.
‡ 'Zool. Anzeiger,' i. (1878).

tube, connected at the end with the green portion and by the other opening into the bladder.

The entire tubular gland is lined by a single layer of epithelial cells, outside which is a fine structureless tunica propria, containing strongly refracting nuclei. There is no cuticular lining to the tube, which thus differs very markedly from the Malpighian vessels of insects. In the yellow portion the cells are sharply defined and convex on their inner surface. In the green part of the tube the cells are large, and their protoplasm is in connection with a peculiar network of pseudopodial processes which extend into projections of the wall into the lumen of the tube. In the proximal portion (that nearest to the green section) of the white part of the tube the walls are smooth, and lined by small cells approaching the pavement form. In its distal portion mammilliform or dendritic processes of the wall project into the cavity, often giving the tube a spongy appearance, and the cells have long broad processes developed from their inner surfaces. The epithelium of the bladder agrees with that of the smooth portion of the tube.

The products of secretion are seen in the white and green but not in the yellow portion of the gland, as yellowish, rather highly refracting drops on the surface of the cells. Probably the yellow part secretes a substance soluble in alcohol. That part of the white tube with tesselated epithelium most likely acts merely as a duct.

The anterior portions of the gland and bladder are supplied by a branch of the antennary arteries, their posterior portions by the sternal arteries; these break up into a rich network of capillaries in all parts of the gland. The nerve supply of the bladder is also derived from two sources, its first part being supplied by a branch of antennary nerves (coming from the supra-œsophageal ganglion), its hinder part by a nerve from the infra-œsophageal ganglion. No nerves were observed in the gland itself.

Action of the Heart of the Crayfish. — M. Felix Plateau, of Ghent, has succeeded in applying the graphic method to the study of the heart's action in the crayfish. A curve is obtained, of which the ascending portions correspond to diastole, and the descending to systole, contrary to what obtains in the Vertebrate heart. It is strikingly like the trace of the contraction of a muscle; a rapid, almost sudden ascent, with a short flat summit, then a gradual descent, at first quicker, then slower. This, however, does not represent the whole truth; it is possible also to demonstrate a wave affecting the muscular wall of the heart, and travelling from behind forwards, thus demonstrating that this condensed heart is a true dorsal vessel. On the stimulus of the entrance of renovated blood, it is only the hinder half or two-thirds of the heart that contracts immediately. This forces blood into the forward half, which contracts only when the posterior division is again dilating. When the temperature is increased, as a general rule the diastolic phase is abbreviated, the number of pulsations rising at the same time. M. Plateau has also succeeded in making experiments on the action of the cardiac nerve of Lemoine, an unpaired branch of the stomatogastric ganglion. It

is proved that excitation of this nerve quickens the pulsations of the heart and augments their energy, while section of it slows the heart. Excitation of the thoracic ganglia always retards the heart, the converse of the cardiac nerve. Acetic acid applied to the heart substance arouses its contractions even when they have ceased, and maintains them for several hours.

The action of a number of other substances is equally noteworthy, and M. Plateau's full communications to the Académie Royale of Belgium will be awaited with interest by physiologists.*

Natural Classification of the Spiders.—Dr. Bertkau points out† the great difficulty of classifying the group; comparing them with the Insecta (Hexapoda), he says that the body is only divided into two regions, that there are no antennæ or wings to aid in discrimination, and that even those parts, which vary in other Arthropoda, present in them a remarkable uniformity; thus there are almost always eight eyes, and a variation in the number of these is of doubtful value, the mouth-organs are always of the same structure, and the number of joints in the legs is very fairly constant; nor do the spinning warts afford any greater aid. Turning to the variations in their habits, he observes that Aristotle, just as much as the latest systematists, drew attention to the difference in the characters of the web, and of the methods by which these creatures obtain their prey, but these differences are of no value as aids to classification from a morphological point of view.

In the present essay an attempt is made to take into account all the variations in organization, and to use only the characters of the web as a last resource, for the very excellent reason that these are of no assistance in the classification of dead Spiders. The following is a short outline of the grouping here proposed:—

Sub-order I.—*Tetrasticta;* two pairs of stigmata on the lower surface of the abdomen; ovaries and testes circular, the entrance to the seminal pouches simple, and just in front of the orifice of the oviduct.

i. *Atypidæ;* with eight eyes, all four stigmata leading to the "lungs"; six spinning warts, the anterior pair short, and consisting of one joint; mandibles horizontal in direction; more than one receptaculum seminis.

ii. *Dysderidæ;* with six eyes, the two hinder stigmata leading into a tracheal system; the six spinning warts sub-equal, and all consisting of one joint each; mandibles vertical, or directed obliquely forwards; only one receptaculum seminis.

II. *Tristicta.*—Only one pair of stigmata on the lower surface of the abdomen; ovaries and testes in two branches; there are ordinarily two openings into the seminal pouches.

These are divided into nineteen families, many of which have well-known names, though their limits are in most cases revised; their relations to one another are exhibited in a genealogical tree.

The author considers that the *Tetrasticta* are the more primitive

* 'Nature,' xix. (1879) 470.

† 'Arch. für Naturgeschichte,' xliv. (1878) 351.

forms, basing this chiefly on the presence of two pairs of stigmata, and the simplicity of the male copulatory organs; palæontology, however, affords some support to his views, inasmuch as *Protolycosa* belongs to this group. With regard to this fossil form, Bertkau suggests that the backwardly directed spinous processes found on the right side represent the hinder pair of spinning warts, and that the small spines on them are the spinning tubes.

Researches into the Developmental History of the Spiders.—The indefatigable Barrois has a preliminary chapter on this subject in M. Robin's Journal.* The chief aim of the author was to examine the arrangement of the germinal layers, and the mode of development of the internal organs; this work, which has never yet been undertaken, was effected by the aid of fresh ova, and of sections stained by bichromate of potash and osmic acid. Passing by some remarks on the relative value of the observations of Balbiani and of Ludwig, in which attention is drawn to the highly granular character of the protoplasm of the formative layer, we note that Barrois adds something to the observations made by Claparède on the primitive streak; the latter admirable student had noted the appearance of thoracic, abdominal, and post-abdominal zonites, but he did not note the presence of two cords, formed of several rows of embryonic cells; to these Barrois gives the name of *germinal bands;* they are derived from a primitively continuous mesodermal layer, and are found throughout the whole length of the body, although they are largest in the thoracic region; in this they may be seen to be dividing into a median (nervous) and a peripheral portion; more anteriorly, they form the cerebral lobes (procephalic lobes of Claparède and Huxley); on the whole this region is, at this period, strikingly like the same parts in the Scorpions, the development of which have been already described by Metschnikoff. Behind the thoracic region there are ordinarily ten zonites, of which the first four are provided with the rudiments of appendages.

By following out the stages of development step by step, Barrois has been enabled to discover a stage—to which he applies the term *Limuloid*—which was not observed by Claparède. In this state the embryo has an exceedingly remarkable appearance; it is divided into two distinct parts, thoracic and abdominal; the posterior portion is formed by the fusion of all the tergal arcs, in which, however, it is possible to observe a pre-abdomen, consisting of six, and a post-abdomen, consisting of four segments. Of the former series four are larger than the other two, and are seen to be provided with appendages; the anal segment, if examined from its ventral surface, is found to be made up of three segments, so that there are altogether twelve segments in the abdomen, or six in the post-abdomen, and the number of these in the Spiders is found to correspond with those of the same region in the Scorpions. In one of the Xiphosura, *Hemiaspis limuloides*, the arrangement of parts is strikingly similar to what is here observed in the embryo of the Spider; the higher development of

* 'Journ. Anat. Phys.,' xiv. (1878) 527.

the first four abdominal segments appears to be a constant phenomenon in the Arachnida; in explanation of this it may be observed that these segments appear together and before those that succeed them, and that the same remark applies to the ganglia that innervate them. The vitelline portions of the egg are also of great interest; the "vitelline vesicle" forms a sac on the ventral surface, just as in Fishes, and as in them it owes its existence to the presence of too much yolk; Barrois believes that attention is now for the first time drawn to the presence of this body in any Invertebrate. The succeeding stages are too briefly indicated for us to be able to give any shorter account of them; there are a number of figures in illustration.

New Genus of the Cheliferidæ.—M. E. Simon has found * that many of the forms of this group which came to hand are not indigenous to the French fauna; the one now to be mentioned was found in a chest containing some Japanese objects, and is eliminated by M. Simon from the "*Arachnides* de France," of which he is preparing a monograph. The name *Lophochernes* (*bicarinatus*) is given to it; it has most of the characters of *Chelifer*, but the second cephalothoracic groove is much deeper than the first; the first five abdominal segments are strongly carinated at the sides, which is not the case with those that succeed them. The movable portion of the chelæ is strongly curved, and only touches the fixed part by its tip when the pincer is closed.

New Acarina.—Dr. Kramer points out † that the observation of Claparède as to the enormous number of these forms is confirmed by every new series of observations; these forms are moreover most remarkable, while they never lose the characters common to their family; the divergencies seen in them cannot be explained as due to different habits of existence, and as yet comparative embryology has been able to throw but little light on the question. The true naturalist must, therefore, content himself for the present by bringing together the material which shall aid later observers in giving a more general review of the group. With this object in view he proceeds to deal with some new forms; two new genera, *Labidostoma* and *Gustavia*, and six species of already known genera are described.

Organization of Myriapoda.—The Myriapoda collected in Turkestan by Fedtschenko have been examined by N. Sograff of Moscow, who gives in the 'Zoologischer Anzeiger' a preliminary account of the chief results he has obtained.‡

1. On the under side of the head of *Chilopoda* occur a quantity of chitinous plates, which are not of a segmental nature, but are mere cuticular thickenings (sclerites) serving for the attachment of muscles.

2. The alimentary canal is lined with very peculiar epithelial cells of two kinds; the first are long and fine, and bear more resemblance to the olfactory cells of Vertebrates than to the cells usually found in the gut of Arthropods; the second kind are oval or rounded,

* 'Bull. Soc. Zool. de France,' iii. (1878) 66.
† 'Arch. für Naturgeschichte,' xlv. (1879) 1.
‡ 'Zool. Anzeiger,' ii. (1879) 16.

and contain brown granules: the rectum is also lined with a characteristic epithelium.

3. The circulatory system consists of a very narrow dorsal vessel, the walls of which are composed of annular striated muscles; the alary muscles appear to exist only in *Scolopendra*.

4. The tracheæ agree in their disposition and external appearance with those of the larvæ of insects (Lepidoptera), the stigmata are provided with a simple but very characteristic valvular apparatus.

5. The brain consists of fibres, and of cells of two kinds. The fibres have a reticulated arrangement in the interior; the cells of the first kind are large, and uni-, bi-, or tripolar: those of the second kind are much smaller, round or elliptical, and correspond to the cerebral granules (Hirnkernen) of Dietl. The form of the brain is correlated with the number of eyes and with the length of the body; the longer the body of the Chilopod, the fewer are its eyes, and the smaller its optic lobes. The latter are wholly absent in the *Himantaria*.

6. The structure of the eye resembles that of insect larvæ. The eyes of the *Lithobii* and *Scolopendræ* are quite like those of the larva of *Acilius*, &c., or those of Spiders. The compound eye of *Cermatia* consists of a number of lesser eyes, closely resembling those of the larvæ of *Hymenoptera*. The optic lobes terminate in a small nerve, the branches of which go to the separate eyes.

7. The genital organs are very peculiar with regard both to their external and internal structure. The ovary agrees closely in structure with that of *Arachnida*. The eggs are disposed in grape-like bunches, the ripe ones being covered with a layer of cells, probably epithelial. The recepticula seminis exhibit epithelial and muscular layers. The testis is filled with large quadrangular mother-cells with large nuclei, probably derived from the epithelium of the thin upper part of the gland. Its walls are invested with strong muscular bundles and a layer of nuclei. The walls of the vesicula seminalis consist of an epithelial layer and of a delicate network of muscles.

8. Glands occur in great numbers in the mouth, in the thorax, on the outer surface of the body, and on the appendages. The pores on the coxæ (Coxalporen) are also glandular. The duct of the poison gland is a strong chitinous canal with small tubules of the same material opening into it; each of these tubules terminates in a pear-shaped gland-lobule. The whole gland-system is covered with a characteristic layer of muscular fibres: so also is the nervous system.

9. The organization of the short Chilopods with comparatively few legs (*Lithobius*, *Cermatia*, *Scolopendra*) is higher than that of the long *Geophili* and *Himantaria*.

10. Of the other *Arthropoda* the *Chilopoda* are most nearly related to the larvæ of *Lepidoptera*, *Hymenoptera*, and *Coleoptera*.

Polyxenus lagurus, De Geer.—Haller makes some remarks* on this curious little Myriapod, which he got from under the bark of old cherry-trees, though never in brushwood or hedges; he draws attention to the structures found in the caudal appendages of these animals, and

* 'Arch. für Naturgeschichte,' xliv. (1878) 91.

points out how closely they resemble in form the siliceous spicules of various Sponges. He has observed how greatly these are in the power of the small spiders that live with them, and which are able to paralyze their action although not able to destroy them.

Parthenogenesis in Bees.—MM. Perez and Sanson have each an article in the last number of the 'Annales des Sciences Naturelles' (Zool.),* in which they repeat and confirm the views already expressed on this subject. See p. 88 of this Journal.

Spinning Glands of the Silkworm.—Each of the two spinning glands Professor Lidth de Jeude describes † as consisting of three parts; a thin-walled efferent duct, a thick and slightly coiled reservoir, and a long and greatly coiled hinder portion. In all three it is possible to make out a thin and homogeneous membrana propria, and a unicellular layer of pavement-epithelium; at the commencement of the median portion of the glandular region there is also a firm cuticular *intima*. The *tunica propria* is traversed by tracheal ramules in the median and hinder portion of the gland, and numerous branches of these pass into and between the epithelial cells; each of these cells contains several twigs. The cells of the glandular epithelium differ in character in each of the three regions, but they all agree in displaying the absence of a distinct membrane, the presence of large stellate nuclei, and a colourless protoplasm. The largest and flattest cells are found in the median, and the smallest in the anterior part.

With regard to the efferent duct, it is noted that the protoplasm of its cells consists of closely approximated doubly-refracting fibrillæ set in a singly refracting substance; they are placed at right angles to the axis of the canal and give the micro-chemical reactions of albumen. The protoplasm is separated from the *intima* by a transparent, singly refracting layer, which is traversed by pore-canals; this layer is easily broken up by treatment with alkaline reagents.

The *intima*, which is about $\frac{18}{1000}$ mm. thick, is of a yellowish-brown colour, is very firm, elastic, and doubly refracting; it is fibrous in structure, but the fibres are not destroyed by alkalies. The lumen of the efferent duct is filled by a colourless fluid, and the filaments found in it are highly refracting and are anisotropic. The protoplasm of the cells of the median portion is finely granular, and is not anisotropic; it differs in character in different regions; the fibres which are found at the periphery of the tube are also essentially protoplasmic in character, and are not chitinized. The very wide portion of the median region is in the posterior portion completely filled by the highly refractive and viscid secretion which is found in it, and which goes to form the silk-threads.

The cellular protoplasm of the hinder portion of the gland is granular, and consists of irregularly prismatic bodies; the cell-substance is, when dried, highly refractive.

The following are the more important physiological results recorded by the author: When living glands were electrically irritated,

* Vol. vii. (1879).

† 'Zool. Anzeiger,' i. (1878) 100.

the contents of the glands were expelled with greater rapidity; tetanization had a more marked effect, and produced changes in the characters of the cells; the most important of the chemical elements found in the fully formed silk-thread was fibrous; the yellow colouring matter was observed to be formed in the cells of the median portion, and it was also noted that the silk-threads did not exhibit their special characters, or power of refracting light, unless they were taken from the region in which the two efferent ducts were found united.

Odoriferous Cells in Lepidoptera.—The observations of Fritz Müller on the attractive properties possessed by the males of certain Lepidoptera revealed the presence of certain cells which seemed to give off an odorous oil of the ether series; the scaly cells to which this oil owed its existence were never, however, found on the *costæ*, where, as it was imagined, the living cells of the wings were alone found. Dr. August Weissmann now * points out that this last supposition is erroneous, and that the other cells of the wing form a connected network of irregularly-branched stellate cells, which are placed in more or less closely set transverse rows below the scales, though they can only be made out by the use of reagents.

The scale itself is capilliform, and traversed by a single axial canal, which opens freely at the tip (as in *Papilis protesilaus*), or there are a number of canals, which open on to the surface of the scale. It is in the butterflies of Brazil or the Tropics that the odoriferous cells are best developed, although indeed in *Pieris napi* it is quite easy to convince oneself that the odour is given off from the scales, by passing the finger over the wing; the finger will be found to retain a strong odour, not unlike that of citrons. In the closely allied species, *P. rapæ*, the same may be observed, but in it the odour is less strong and of a different character.

In connection with these observations of Weissmann, we may draw attention to the communication which Fritz Müller has made to his brother Hermann; † he says that he finds his nose gets sharper in detecting odours from butterflies; thus, the male of *Callidryas trite* was two years ago odourless, but he is now easily able to detect its odour. In the male of *Didonis biblis* he has now observed three distinct odours in different parts. The females of *Callidryas* have highly odorous glands connected with their generative organs, which give off an acetous scent; while the males of the same form have a musk-like odour from the same parts.

Seasonal Dimorphism of Lepidoptera.—Dr. Kramer makes some elaborate computations ‡ as to the modes by which this dimorphism, the phenomena of which have been so learnedly treated by Professor Weissmann, have been evolved; a severely mathematical study leads him to the following conclusions:—

1. By the cumulative action of *transmission* (heredity) a large

* 'Zool. Anzeiger,' i. (1878) 98. † Ibid., 32.
‡ 'Arch. für Naturgeschichte,' xliv. (1878) 411.

number of animal groups have been derived from the same species, and exhibit various grades of variation.

2. Those groups which are most and those which are least altered are the less numerous, while those which have undergone the mean amount of variation are the most numerous.

3. The series of variations is an unbroken one.

4. These variations are not affected by any length of time.

Development of Podurella.—There is a short note in the 'Revue Internationale des Sciences,' vol. ii. p. 439, on the investigations of Barrois. In the anterior region the sternal arcs are found to be, as in other insects, the first formed, and to be developed from below upwards; the cephalic lobes, the antennæ, and the labrum can soon be made out in the cephalic region; then follows the mouth, then six pairs of limbs, of which the first three go to form the labrum and the mouth-organs, while the other three develop into the thoracic limbs.

In the abdominal region, it is very different; the tergal arcs are the first to be formed, and development takes place in a dorso-ventral direction; in this stage the insect is said to have no slight resemblance to the Zoëa form of the Crustacea.

Respiratory Organs of the Larva of Culex.—These are seen by Dr. G. Haller * to be excellent examples of an intermediate stage between the arrangements found in the larvæ of the Phryganida and of the Ephemerida on the one hand, and in such adult forms as *Nepa* or *Ranatra* on the other.

Two well-developed longitudinal trunks extend through the whole body, and supply all its parts with air; they are extremely delicate, and are provided with a fine spiral band of chitin; just before reaching the cephalic segment they turn inwards at a right angle; at this point there is developed a contractile vesicle, to which the older observers gave the epithet "respiratory"; examination of its structure reveals, however, its essentially glandular character, and proves that it is connected with a cellular cord placed in the cephalic region. So far as is known, these creatures are not provided with any salivary glands, but the organ in question greatly resembles one. In the terminal segment of the body the tubes pass towards the middle line, and form respiratory tubes, placed one above the other; the author distinctly affirms that they do not unite, and that they even open separately; above these openings there are three sharp, projecting, points, which are capable of being closed, and of thus forming a kind of valvular projection against the entrance of water or other fluids. So long as the animal remains at the surface, these tubes are freely open to the atmosphere; but when it is forced to descend into the water, the tracheal gills, now to be described, come into function. These gills have the form of delicate elongated lamellæ, in which the terminal branches of the tracheæ are found to ramify; they are placed on the opposite surface of the body to the respiratory tubes, and are provided with long branched hairs, of which there are generally eleven.

Where the branches that supply the tracheal gills are connected with the longitudinal and primary air-vessels, an air-reservoir is deve-

* 'Arch. für Naturgeschichte,' xliv. (1878) 91.

loped; these consist of one or more tufts of a large number of short ramules; their function appears to be to supply the organism with air during such short periods as those in which respiration is prevented or retarded; the hairs are better developed on the side nearer to the respiratory tubes than on the other. Very much the same relation of parts is found to obtain in the pupa.

In the imago the conditions appear to be altogether different; the insect now respires by the aid of stigmata. The hairs on these structures are described in some detail, and the descriptions illustrated.

Sucking Plate of Dytiscus.—The same author describes * the chitinous organs on the sucking plate on the first pair of feet in the males of Dytiscus. These, which appear to be of aid in copulation, are formed by the differentiation of the first joints; in copulation they are applied to a shallow groove on the thorax of the female; they are cordiform in shape, and are formed from three of the joints of the tarsus; in colour they are more or less red or brown, and on their upper surface they present a roughened, file-like surface, which is produced by the presence of a number of rounded, flattened organs, some of which may be easily perceived by the naked eye. In some, the structure is remarkable on account of the presence of radiating, yellowish, and branching chitinous hairs, separated by a colourless transparent membrane, which is more or less distinctly striated; on the inner surface of these organs there are rounded bodies which produce a dark brown secretion, the function of which appears to be to protect the bodies in question against the action of water. In others there are several transverse rows of smaller bodies; these consist of a single hollow chitinous hair, which is closed at its tip; this again is provided with a transparent chitinous membrane of a brownish hue. Adding together all the prehensile structures observed on these appendages, the author comes to the conclusion that there are no less than four hundred of them, the power of which is at once apparent. The plates now described are provided with a number of hairs of two kinds; in one they are long, firm, blunt, and curved a little inwards, so as to afford a protection for the subjacent structures; the others are broad and short, are distinctly striated in a longitudinal direction, and are inserted into strong chitinous rings.

Development of Polyzoa.—M. W. Repiachoff, of Odessa, has studied the development of *Tendra zostericola*,† of *Lepralia pallasiana*, and of two species of *Bowerbankia*.‡ In *Tendra* complete yolk-division takes place, and an equal-celled mulberry-mass (archimorula) is produced, which soon becomes hollow by the formation of a cleavage cavity, producing a one-layered archiblastula. Four cells lying together in the centre of the ventral side, then enlarge greatly, and undergo extensive division, forming a mass of cells projecting into the cleavage cavity. This mass is the endoderm; its cells soon separate from one another, forming a cavity, the archenteron, which is

* 'Arch. f. Naturgeschichte,' xliv. (1878) 91.
† 'Zeitsch. f. wiss. Zool.,' vol. xxx. Suppl. (1878) 411.
‡ 'Zool. Anzeiger,' i. (1878).

at first quite closed, but afterwards opens on the exterior by a blastopore, produced by the separation of those endodermal cells which occupy the position of the four cells originally invaginated, on the ventral surface of the embryo. At a still later stage the blastopore thus formed closes up, both mouth and anus being subsequently formed as invaginations of the ectoderm.

The chief fact about *Lepralia* is the confirmation of the author's previously expressed opinion that the structure called "stomach" by Barrois is really a sucker.

The two *Bowerbankia*-larvæ were pear-shaped, with a mantle covering the dorsal and ventral surfaces, and a mantle-cavity opening by an aperture at the small end of the embryo. The larger specimen had on its flattened ventral side an elongated ciliated aperture, in relation with which, in the interior of the body, was a granular mass representing the endoderm. On the ventral side of both was a longitudinal groove, bounded by two folds, and resembling the medullary groove of a Vertebrate. In the smaller specimen this was continuous along the whole ventral side; in the larger it was interrupted by the ciliated aperture just mentioned.

In both larvæ there was a shallow annular constriction round the middle of the body, and, at the same place, a thickening of the mantle. A second constriction, with a corresponding thickening of the mantle, occurred between the first, and the thin end of the body. Corresponding to these constrictions, there was, in the smaller larva, a weak indication of segmentation of the ventral (supposed medullary) folds.

The early stages of development in the *Ctenostomata* (the group to which Bowerbankia belongs) resemble in a general way those of *Tendra*, but the gastrula approaches more nearly to the simple archigastrula.

In a further communication Repiachoff * has studied more carefully the later developmental stages of *Tendra*, of which only a brief account was given in his former paper. He states that he has proved the sucker of the embryo ("stomach," Barrois) to originate as a thickening of the ectoderm on the ventral side of the body. He also describes the blind endodermal sac or midgut of the embryo as extending uninterruptedly quite to the upper end of the body; above, therefore, the involution which becomes the foregut. Subsequently this upper portion of the endoderm becomes separated from the remainder, and forms a mere accumulation of cells in close proximity to the oral furrow. The remainder of the endodermal sac fuses with the foregut involution, and forms with it a semi-lunar alimentary canal.

Presence of a Segmental Organ in the Endoproct Polyzoa.—In October, 1877, Hatschek of Prague discovered in *Pedicellina echinata*, both in the larval and adult state, a vibratile canal which he apparently could not quite make out, and which he compared to the vibratile organs of the Rotatoria. M. L. Joliet has confirmed †

* 'Zool. Anzeiger,' ii. (1879) 68.
† 'Comptes Rendus,' lxxxviii. (1879).

these observations, and extended them to the whole group of Endoproct Polyzoa.

In some *Pedicellinæ* which he observed the vibratile organ was double, and situated in the cavity of the body in the space comprised between the œsophagus, the stomach, and the matrix. It was composed of a short tube, ciliated on the interior surface (swollen in the middle), which on the one hand opened into the matrix not far from its external orifice, and on the other opened obliquely into the cavity of the body, by a mouth slightly bell-shaped and furnished with active vibratile cilia.

This organ, provided with a vibratile mouth, and placing the cavity of the body in communication with the exterior, has all the characters of a segmental organ. It appears very early in the bud. When the stomach is only outlined, and before the tentacles appear, a ciliary movement is seen at the place which it subsequently occupies.

M. Joliet observed the same organ in a second species of *Pedicellina*, and in *Loxosoma*, and he considers that in the Endoproct Polyzoa may be regarded as constant the presence of an organ widely distributed in the worms. In face of the attempts which have been made in later years to bring the Polyzoa and the Annelida together, it seems to him useful to put forward his observations.

Power of Locomotion in the Tunicata.—Mr. W. Macleay, F.L.S., has observed,* with some astonishment, that large Ascidians which he found strewn at low water on a sandy beach after a storm, are or seem to be capable of a certain amount of locomotion—they do change their positions most undoubtedly; in doing so they leave upon the wet sand a distinct track in accordance with the weight and size of the mass, and these movements are not in any way attributable to winds or waves. He at first thought it possible that the movements might be due to the agency of some of the animals adhering to the outside of the mass, but he found that the only organic attachments, excepting a few small shells, were clusters of simple Ascidians utterly incapable, therefore, of combined action, and much too small for their individual efforts to produce any effect.

Notwithstanding, however, this apparently convincing evidence, he is indisposed to believe it possible that an animal so completely shut up in a thick coriaceous unmuscular sac, can have any power of external movement, nor is it likely that such a power would be possessed by an animal whose whole life (except in infancy) has to be passed firmly rooted to the bottom of the sea, and he hopes that some one having the leisure and opportunity will endeavour to solve this problem.

Extension of the coiled Arms in Rhynchonella.—Years ago Von Buch recorded that Otto Frederic Müller had observed the Brachiopod *Rhynchonella psittacea* protrude its arms beyond the anterior borders of the shell. This single observation was not widely accepted, and many doubted the possibility of the arms being exserted in this

* 'Proc. Linn. Soc. N. S. Wales,' iii. (1878) 55.

manner. In the year 1872, while studying living *Rhynchonella* in the St. Lawrence, Mr. E. S. Morse observed * a specimen protrude its arms to a distance of four centimetres beyond the anterior borders of the shell, a distance nearly equalling twice the length of the shell. This year he again had an opportunity of studying it in Hakodate, Yesso, and again observed the same features. Specimens lying on the bottom of a glass dish protruded their arms a short distance, and remained in this position for hours. The movements of the arms were very sluggish, though the cirri were constantly in motion. Sometimes the shells closed upon the arms before they were retracted. *Lingula* has the power of partially protruding its arms, as he has repeatedly observed in North Carolina and Japanese species. *Terebratulina* can also partially protrude the cirri.

Eye of the Lamellibranchiata.—It is peculiarly interesting to observe that the "visual purple" which the researches of Franz Boll and Kühne have made known to all microscopists is to be observed in the eyes of some of the Invertebrata; Professor Hensen calls attention to this matter † in reference to certain observations made by Krukenberg on the eyes of the *Cephalopoda*. Hensen has observed in *Pecten Jacobæus*, that the layer of rods is distinguished from the surrounding parts by its coloration. Krukenberg in his notice concludes that in the *Cephalopoda* the colour is persistent, but in *Pecten* Hensen noted its rapid disappearance. Hensen also corrects some of his observations on the eye of this Lamellibranch, which were published a few years ago.

Foot of the Unionidæ.—J. Carrière has been making some observations ‡ on the foot of the *Unionidæ*, which have led him to the following conclusions: the injections of the lacunæ and blood-vessels, which one is, at times, able to make through a cleft at the margin of the foot, are effected by the destruction of fine tissues; this cleft does not, that is, communicate with the vascular system, but is the aperture of a closed, and variously developed gland. This organ often contains a yellow secretion. The various stages of its development are indicated, and it is pointed out that it is greatly reduced in *Unio*, where indeed it may be merely represented by a short ciliated canal. It is concluded that it represents a rudimentary byssus gland, and the author promises more complete details.

"Digger" Mollusc and its Parasites.—The little digger, *Donax fossor*, represents a countless mass of life off Cape May, New Jersey, large areas looking like barley grains lying on a malting floor when the tide retires. It gets uncovered by the breaking surf and instantly reburies itself with its powerful foot when the waves retire. The siphons are long and active, looking like so many wriggling worms. Although the prey of shore birds and fishes, and beset with parasites, they lie so thick as even to interfere with one another in burying themselves. The liver of these bivalves is always found

* 'Am. Jour. Sci. and Arts,' xvii. (1879) 257.
† 'Zool. Anzeiger,' i. 30. ‡ Ibid. (1878) 55.

beset by flukes, from half-a-dozen to several dozen, and a bell-shaped trichodina crowds the branchial cavity.*

Hermaphroditism in, and the Spermatophores of the Nephropneustous Gasteropoda.—Dr. Pfeffer describes † the arrangement of the generative organs of some of the *Nanidina* in the Berlin Museum; the genus *Trochanina* is founded on external characters, but the examination of the internal parts has brought to light variations in structure, which should lead to the breaking up of the genus. The forms which compose it are distinguished by having an accessory gland to the penis and by the absence of the retractor muscle of this organ; in *T. Schmelziana* and *T. radians* the seminal duct is connected with the lower portion of the penis by well-developed connective tissue, but in the other species it is connected by a muscle with the uppermost parts of the uterus. In some still more divergent forms there is a duct connecting the prostate with the stalk of the vesicle.

The arrangements in *T. ibuensis* are such as to make copulation impossible, as the penis has no efferent duct, and the sole orifice is that which belongs to the oviduct; the presence, however, of the just-mentioned duct atones for this structural defect, or, in other words, renders the penis unnecessary. In *T. percarinata* the duct was likewise present, and no orifice could be detected in the penial papilla. In the other forms there are no apparent arrangements for self-impregnation, though there are difficulties, such as for example the absence of a retractor penis, set in the way of reproduction by copulation.

The spermatophores were found in the penis, or in the bladder, and there might be, in different species, one, two, or even three of these bodies, with fragments of others. They exhibit in most cases the same general characters; they form a sausage-shaped body invested in a thin, white, horny covering, provided at one end with a spine-shaped projection, and continued at the other into a thinner, long, dark brown tube; this tube becomes semicircular towards its free end and terminates in an enlargement, which is provided with one or two crowns of spines. When acted upon by water, the contents swell towards this end; they are then seen to contain a number of hyaline chitinous fibres, and some oval or lancet-shaped calcareous corpuscles, such as are generally, if not always, found in the penis of the *Zonitidæ*. The spermatophores are, it is concluded, developed in the flagellum of the penis, or through the whole extent of this organ; and, from the complexity of their structure, it is thought to be unlikely that there is a second formation of spermatophores during the same copulation period.

Mucous Threads of Limax.—Dr. Eimer, having described ‡ the habits of *Limax agrestis*, and having observed that he was unable to find any reference to their powers of producing mucous threads, induced Professor Martens to make some remarks on the subject, § of which it may be interesting to give a short account.

* 'Nature,' xix. (1879) 470.
† 'Arch. für Naturgeschichte,' xliv. (1878) 420.
‡ 'Zool. Anzeiger,' i. (1878) 123. § Ibid. 249.

Martin Lister, two hundred years ago, noted the production of filaments 2 feet long; Shaw, in 1776, observed filaments 8 feet from the ground, and Hoy, in 1789, gave an account of them to the Linnæan Society. For many years these and similar observations seem to have been well known, but since the time of Woodward, Johnston, and Moquin-Tandon, no information is given in the more popular manuals. Professor Martens notes as a curious fact that the majority of observations on the habits of *Limax* has been made in Great Britain, anp, though making full allowance for the superior advantages of our damp climate, thinks that the fact is due to the better instruction and greater interest of our naturalists. He observes, that the power of producing these threads is not confined to Limax, but that *Megalomastoma suspensum* in the West Indies, and *Potamides obtosus* on the coasts of Borneo, have been observed to have it also; and, noting the striking resemblance between these, and the byssus-threads, concludes by observing that there are marine Gasteropoda capable of producing similar filaments.

BOTANY.

A. GENERAL, INCLUDING EMBRYOLOGY AND HISTOLOGY OF THE PHANEROGAMIA.

Development of the Embryonal Sac.—The following are the summarized results of M. J. Vesque's researches on this subject.*

1st. In Angiosperms, the embryonal sac of Brongniart is not composed, as in Gymnosperms, of a single cell; on the contrary, it results from the fusion of at least two cells superposed and at first separated by septa.

2nd. The cells which are destined later on to compose the embryonal sac, all proceed from one and the same primordial parent-cell. M. Warming, who discovered them, rightly gives them the name of special parent-cells, comparing them to the parent-cells of pollen or of spores. This comparison is justified by the physical characters of the septa.

3rd. When the development of the special parent-cells is completed, each gives rise to four vesicles homologous to the four pollen grains which originate in one and the same parent-cell.

4th. The variations to be observed in the different types of Angiosperms depend on the more or less early arrest of development which happens to the special parent-cells.

5th. The first cell always produces the sexual apparatus. It blends with the second cell, in order to constitute the major part of the embryonal sac. When the second cell has produced its four vesicles, the eight free vesicles of the embryonal sac behave in the manner described by Strasburger in the cases of *Orchis* and *Monotropa*. This fact is observed in certain Monocotyledons and apopetalous Dicotyledons.

6th. The other special parent-cells (the third, fourth, and fifth) may produce the four vesicles. Each of the vesicles is homologous with the pollen grain, and it is convenient to retain for it the name of *antipodal vesicle*. When these parent-cells persist in their primi-

* 'Ann. des Sci. Nat. (Bot).,' xi. (1878) 276.

tive state without producing vesicles, they themselves simulate superposed, not juxtaposed, antipodal vesicles. These differ from the former in a morphological point of view, and M. Vesque gives them the name of *anticlinal cells.*

This state has been observed in several Monocotyledons, certain apopetalous Dicotyledons, and in almost all the Gamopetalæ.

7th. The second cell appears to be the first to undergo an arrest of development. In this case its vesicle directly becomes the proper vesicle of the embryonal sac, and this cell does not produce any antipodal vesicle. This fact, observed in some Monocotyledons and Apopetalæ, becomes the rule in the Gamopetalæ, which are from this point of view the farthest removed from Cryptogams.

8th. In the Gamopetalæ (with some very rare exceptions) the first cell alone produces a complete or incomplete tetrad, which is nothing but the sexual apparatus composed of two, three, or four vesicles. The second cell seems to take upon itself the vegetative rôle of the embryonal sac. Its undivided vesicle becomes the vesicle of the embryonal sac.

The cells 3, 4, 5 (or 3, or 3 and 4, according to the number of the special parent-cells) are anticlinal vesicles, or produce antipodal vesicles by dividing their vesicles.

9th. In the greater number of Gamopetalæ, the formation of the endosperm is connected with the ulterior development, by division, of one or many of the special parent-cells. These latter being homologous with the parent-cells of spores, it is permissible to consider the endosperm of these plants as a sterile female prothallus.

Protein-crystalloids.—Dr. A. F. W. Schimper, son of the well-known bryologist, has recently published a treatise on this subject.* He finds the crystalloids contained in seeds, to which he has paid most attention, to belong mostly to two systems; some are hexagonal-rhombohedral-hemihedral; while others are regular tetrahedral-hemihedral; the former again being divisible into three species. Their crystallographic properties agree with those of true crystals, except that, as Nägeli has already pointed out, their angles are somewhat less constant. Regular crystalloids swell up in water equally in all directions, and therefore undergo no change in form; the swelling of hexagonal crystalloids is, on the other hand, accompanied by certain changes both of form and of optical properties. Crystalloids are, however, perfectly distinct from true crystals; the same substance never occurs both as crystalloid and crystal.

Composition of Chlorophyll.—Some further researches on this subject are recorded by Professor Dippel.† He starts with the observation that neither of the substances into which Kraus divided crude chlorophyll, xanthophyll and cyanophyll, are themselves simple substances. Xanthophyll, which is not entirely free from fluorescence, and which is certainly not a product of decomposition due to the presence of water in the alcohol employed, is, according to circumstances, coloured of a more or less distinct blue by acids, and this

* 'Botanische Zeitung,' xxxvii. (1879) 45. † 'Flora,' xxxvi. (1878) 17.

blue fluid can be decomposed, by agitation with benzin, into a yellow and a blue constituent. Cyanophyll can also, like crude chlorophyll, be decomposed, both by agitation and by treatment with potash and alcohol, into a yellow and a green constituent. From an alcoholic solution of crude chlorophyll or from cyanophyll there can, however, be obtained, by treatment with potash and ordinary benzin, a pure yellow substance called by Kraus *xanthin*, in which there is no trace of fluorescence, which is not coloured blue by acids, and which is also recognized by presenting three clearly defined absorption-bands in the more highly refrangible, and a weak band (?) in the less refrangible part of the spectrum. If the potash is precipitated from the alkaline-alcoholic solution which is obtained in the production of xanthin, by means of very dilute sulphuric acid, a beautiful green or bluish-green alcoholic solution is obtained, in which the green constituent of chlorophyll is contained, termed by Kraus *chlorin*. This solution, which resembles chlorophyll in its colour, its fluorescence, and in its property of being turned blue by acids, must be considered rather as a mixture than as a product of decomposition. The yellow colouring matter of leaves and of golden yellow petals, which is soluble in alcohol, presents precisely the same spectroscopic phenomena as the yellow ingredient of chlorophyll obtained by shaking with benzin. From the absorption phenomena of the crude alcoholic extract of the petals of *Eschscholtzia californica*, it is evident that we have a mixture of two constituents, one reddish yellow and soluble in water and alcohol, the other golden yellow, and soluble in alcohol, but not in water. The results are the same with the yellow colouring matter of the petals of *Hemerocallis fulva* and *Dumortieri*, and the ligulate petals of the marigold; and it seems not improbable that the absorption phenomena of other more or less strongly coloured orange petals and coatings to the fruit, such as those of *Berberis Darwinii* and *Euonymus europæus*, are due to similar causes.

B. CRYPTOGAMIA.

Action of Light and Heat on Swarmspores (Zoospores).—In opposition to the observation of many botanists that swarmspores in water group themselves in a determinate way under the influence of light, Sachs has shown by experiment that in emulsions consisting of oil and a mixture of alcohol and water, the fine oil drops also show similar groupings, and that these are caused by currents in the fluid produced by differences of temperature.

All that had been published on the subject was reconcilable with these results, but a statement of Dodel-Port on the behaviour of the swarmspores of *Ulothrix* clashed with this explanation. According to him, the spores in the vessels collected on the side next the window, which, as the experiment was made in winter, was the colder side, while on the other side they flowed towards a lighted petroleum lamp, and consequently to the warmest side. Strasburger then took up the subject, and submitted it to a thorough experimental examination, the results of which are published in the 'Jenaische Zeitschrift für Naturwissenschaften.' *

* Vol. xii. 551.

Strasburger first repeated most of the experiments of Sachs, both with emulsions and with swarmspores, and found the same results in every case. But besides these passive groupings of the swarmspores caused by currents, he observed some that were caused by active movements on their part. These were examined, not in large vessels, but in drops which, hanging from the covering glass in a moist chamber,* could be examined under the Microscope.

The experiments were carried further by applying light of different colours, either by passing it through different coloured solutions before it reached the drops, or by directing the different parts of an objective spectrum on the drops. Lastly, in experimenting on the action of heat, the incident rays were sometimes made to lose their calorific rays by a concentrated solution of alum, sometimes their luminous rays by a solution of iodine in bi-sulphuret of carbon.

The very first experiment showed that in such drops certain swarmspores often moved in a direct course either to or from the source of light; that the movement often took place with considerable rapidity; that it commenced the moment the preparation was exposed to the influence of the light; that a change in the position of the preparation relatively to the source of light resulted in an immediate corresponding change in the direction of the movement of the spores. It had then to be determined whether any and what share in these movements was so due to currents within the drop, and with this object the same experiments were repeated with emulsion drops. The currents, which could then be easily detected in the drop, were, however, under the same conditions and in the same localities, not to one side only as in the case of swarmspores, but always in a very different direction, namely, towards a common centre.

Stronger evidence that active movements were the cause of the grouping of the swarmspores in the drops was furnished by experiments in which different spores in the same drop were exposed to light from one side; when some went towards the light, whilst the others removed from it or remained perfectly still. Of the same nature were the results of experiments made with finely divided inorganic substances (amorphous bromine) and with swarmspores which had been killed by heat or by slight admixture with a noxious substance; they showed none of the movements which were displayed by the living spores in drops of water.

Having thus settled the general phenomenon, Strasburger proceeded to the special examination of the behaviour of different swarmspores under light. For this purpose he used chiefly those of *Hæmatococcus lacustris*, *Ulothrix zonata*, *Chætomorpha acrea*, *Ulva enteromorpha*, *lanceolata* and *β compressa*, *Ulva Lactuca*, *Botrydium granulatum*, *Bryopsis plumosa*, *Œdogonium* and *Vaucheria*, *Scytosiphon lomentarium*, *Chytridium*, and *Saprolegnia*, the swarmspore conditions of *Chilomonas curvata* and *Paramecium*, and others. The behaviour of these numerous swarmspores with respect to light was examined under widely differing conditions. He also examined their behaviour in the dark, the effect of heat and other external influences, that of currents

* See this Journal, i. (1878) 197.

in distributing the spores in large vessels, and the effect of light on the movements of other plant-organs.

The following are the general results arrived at:—

The direction of the movement of certain swarmspores is influenced by the light: these may be termed *phototactic*. This action is connected only with the protoplasm as such, and not with any definite colouring matter, for colourless spores act like coloured ones.

The swarmspores affected by light move in the direction of the incidence of the light, and this takes place in two ways: either it is constant only in the direction of the source of light even when the intensity of the light decreases in this direction, when the swarmspores may be called *aphotometric;* or they follow the decrease of light in the direction of rising or falling intensity, when they may be called *photometric*. No movement is possible in any other direction than that of the incidence of the light, even when the intensity of the illumination rises or falls in any other direction.

The blue, indigo, and violet rays alone have any influence on the phototactic spores, and the maximum effect is produced by the indigo. On the other hand, the yellow and nearly allied rays of sufficient intensity cause a quivering movement in phototactic spores.

On a sudden change in the brightness, many phototactic swarmspores show after effects, the direction of the movement induced by the previous degree of brightness being retained for a short time.

The large swarmspores of *Bryopsis* show after effects only when the intensity of the light is suddenly diminished; when it is suddenly increased, they exhibit a trembling which makes them leave their course for a while. Those of *Botrydium* do not show after effects when the brightness is either suddenly increased or decreased, but they tremble if the light is suddenly cut off. The swarmspores of *Ulvæ* gave no sign either of after effect or trembling.

An increase in the intensity of the light occasions in the phototactic spores for the most part a tendency to settle; direct sunlight more particularly acts in this way; decrease in the intensity of the light heightens their mobility.

The rapidity of the movement is not influenced by light; the spores, however, move in a more direct course the greater the intensity of the light.

In general, moreover, the smaller spores move straighter than the larger ones. The largest, by virtue of their important property of moving in considerable masses, have freed themselves from the influence of light on their direction. But there are also small spores which are influenced comparatively slightly, or not at all, by light.

In the dark the phototactic swarmspores do not settle to rest unless they are sexually differentiated and unite with one another. Otherwise they continue to move till they disappear.

In swarmspores brought from the dark into the light, similar effects may be observed as when subjected to a sudden increase in the brightness.

In general, photometric swarmspores alter in their sensitiveness to light in the course of their development, this being displayed more

when they are young than when they are old; and it exhibits also other variations.

Apart from the alteration in sensitiveness during development, whole batches show themselves to be directly sensible to relatively higher or lesser intensities of light. This appears to depend on the intensity of the light in the spot where they were produced.

Heat exercises for the most part an influence on the photometric sensitiveness of swarmspores. As the temperature rises they become in general more sensitive to light, less so as it sinks.

If there is not a free current of air through the batches, photometric swarmspores are sensitive to higher intensities of light.

Insufficient nutriment prevents the swarmspores from coming to rest, without influencing their sensitiveness for light.*

Floating Algæ forming Scum on the Surface of Water.—The cause of the sudden appearance of green, red, or brown scum on the surface of water, when due to an algoid growth, must be either an extraordinarily rapid multiplication of the alga, or a change in its specific gravity, in consequence of which it rises from the bottom to the surface of water, such as occurs also in the terminal buds of flowering water-plants, as *Hydrocharis*, *Stratiotes*, *Ceratophyllum*, *Myriophyllum*, *Aldrovanda*, *Utricularia*, &c. The organism which constitutes this "Wasser-blüthe" is usually some green alga belonging to the Chroococcaceæ, Oscillatorieæ, or Nostocaceæ. Professor F. Cohn has for the first time detected a *Rivularia* † as the cause of this appearance, on a stream near Lauenburg, in Pomerania, the surface of which was completely covered with a green scum, consisting of an innumerable quantity of minute globes from 0·15 to 0·3 mm. in diameter, bearing a superficial resemblance to Volvox. Under the Microscope they were found to consist of Rivularia-filaments imbedded in jelly, formed of ordinary cells and heterocysts. Cohn considers it a new species, to which he gives the name *Rivularia fluitans*.

About the same time, C. Gobi, of St. Petersburg ‡ observed a similar appearance on the surface of the sea-water in the Gulf of Finland, consisting also of minute green globes from 0·3 to 0·45 mm. in diameter or larger, enclosed in a very thin jelly, to which he gave the name *Rivularia pelagica*. The two species were subsequently determined by Professor Cohn to be indistinguishable from one another. The marine form was seen only when the water was tolerably still, disappearing completely when it became rough, and was accompanied by large patches of another green alga, *Aphanizomenon flos-aquæ* Rlfs., which had hitherto been observed only in fresh or brackish water.

Luminous Bacteria in Meat.—An account has been published § of some observations of M. Nuesch on "Luminous Bacteria on Fresh Meat." A fact of the same kind was noted by the famous Fabricius ab Aquapendente in 1592, who appears to have been the first to observe it. M. Nuesch had some pork chops which were sufficiently

* 'Der Naturforscher,' xi. (1878) 485.
† 'Hedwigia,' xvii. (1878) 1.
‡ Ibid., 33.
§ 'Bull. Sc. Dép. du Nord' (1878) 184.

luminous to enable him to read his watch by their light! On examination, his butcher owned that he first observed it in the recess in which he stored the "débris destinés aux saucisses." Shortly afterwards all his meat became phosphorescent, and even fresh meat brought from a distance to his shop was similarly affected. The moment the meat began to give indications of losing its freshness, the phosphorescence disappeared, and *Bacterium termo* became visible on examination; cooked meat did not put on this appearance, but cooked albumen and potatoes did become phosphorescent, and starch paste became of an orange colour in the presence of this phosphorescent meat; the hands, if rubbed over it, remained phosphorescent for several hours. It is reported that under the Microscope bacteria were observed, and that, in the dark, examination under the Microscope revealed a number of luminous points. In this strange history there are two satisfactory points; the one is that the meat did not differ in smell from ordinary meat, and the other is that we are promised fuller details.

Thuret and Bornet's 'Phycological Studies.'—This magnificent work surpasses anything which has ever been published relating to Algæ. It comprises fifty-one folio engravings by Picart from drawings of Bornet and Riocreux. Most of the plates were prepared under Thuret's direction between the years 1846 and 1856, and several appeared in a reduced form in the 'Annales des Sciences Naturelles' of 1851, as illustrations of his article, 'Recherches sur les Zoöspores des Algues.' It was Thuret's intention to publish an atlas of fifty plates, but, at the time of his premature death, ten of the plates had not been engraved. These were finished under the direction of his friend and co-worker, Dr. Bornet. Never before have the Algæ been so exquisitely delineated, whether microscopically or in gross. The life-size figure of *Fucus platycarpus* is perfection itself. The text is principally by Dr. Bornet, who has inserted when possible the notes and descriptions of Thuret himself. No apology, however, was necessary on the part of the former; for not only was he the constant companion of Thuret, but his style of writing very closely resembles that of his lamented associate. The text modestly purports to be simply a description of the plates. It is, however, much more; it is a very elaborate exposition of the structure and reproduction of the different groups of Algæ. The principal part of the observations on the Fucaceæ have already appeared in the 'Annales.' The part relating to the Phæosporeæ is very clearly presented, and is the most complete account of the order yet published. The fertilization of *Polyides rotundus* resembles that of *Dudresnaya* in the growth of a number of filaments from the base of the trichogyne. The account of the reproduction in the Corallineæ throws a new light on the structure of that order, and for the first time a detailed account is given of the antheridia and cystocorpic spores.*

Relation of Lichens to Algæ and Fungi.—The theory of Schwendeuer, that lichens are not independent organisms, but consist

* 'Am. Journ. Sci. and Arts,' xvii. (1879) 256.

of fungi parasitic upon Algæ, although not generally accepted by lichenologists, has met with great favour from physiologists. Dr. A. Minks promises an important work in opposition to this theory, founded on a long series of experiments, and to be illustrated by a large number of coloured plates. In the meantime he gives a statement of his conclusions, with some of the arguments on which they are founded, in 'Flora.' * His observations were made mainly on a gelatinous lichen, *Leptogium myochroum*, Ehrh., and with a Hartnack's objective with a power of 1250. All the preparations were made in filtered river-water, to which was usually added a larger or smaller quantity of potash ("liquor kali caustici" of the German pharmacopœia, 33½ per cent.). In order to remove the jelly, the preparation was further heated with potash for ten minutes, every trace of the alkali washed away, and dilute sulphuric acid gradually added to the water in which the preparation lay. While the destructive influence of the acid on the true constituents of the lichen is very slow, it has a remarkable effect on the contents of the cells, changing the blue-green of the gonidia at once into a more or less intense steel-blue.

A close observation of the thallus of the lichen in question shows, says Dr. Minks, that there is no clear distinction between the cells of the hyphæ and the gonidia, one passing over insensibly into the other, the two being contrasted simply as different modifications of the same cell. The cloudy granular contents of the gonidia appear, when very highly magnified, as a colourless protoplasm permeated by a smaller or larger quantity of intensely blue-green corpuscles. The colourless contents of the hyphal cells also consist of a protoplasm, but in their axis is a single row of similar but more delicate blue-green corpuscles. The presence of these corpuscles, termed by Körben *microgonidia*, serve to distinguish the cells of lichens from those of fungi, and are the origin of all intracellular new-formation of cells. The microgonidia may be considered as the germ of the new-formation of gonidial chains. A row of microgonidia, increasing by the division of its separate corpuscles, increases the size of the cell which encloses it to its utmost capacity; this mother-cell ultimately becomes dissolved into jelly, and the young chain of gonidial cells is thus set free. The microgonidia gradually grow and finally become invested each in its own cell-wall, becoming thus transformed into ordinary gonidia. In this way an ordinary hypha of the thallus may become transformed into a chain of gonidia. The gonidial cells soon lose all indication of their origin, and increase by the ordinary repeated bipartition or quadripartition. Some cells, however, take no part in this multiplication, remaining unchanged in the form of what are known as *heterocysts* or *metrogonidia*, which also contain microgonidia, like the ordinary cells. The two differentiated products from the same original fundamental tissue — ordinarily called the gonidial system and the hyphal system—our author proposes to term *gonidema* and *gono-hyphema*, the latter always having a potentiality to pass over, at some time or other, into the former. In addition to these, the lichen-thallus contains a third tissue, hitherto neglected, the

* 'Flora,' xxxvi. (1872) 209 *et seq.*

hyphema, the original fundamental tissue out of which the gono-hyphæ are themselves differentiated. This can be best detected in the hypothalline tissue, at the point of origin of the rhizines. Its cells are very minute, and have not the elongated form of those of the gono-hyphæ, but contain, like them, microgonidia. It will be observed that the structure and development of Nostoc agree, in every essential respect, with that just described of ordinary lichens.

In addition to the ordinary mode of reproduction of the thallus of lichens which the author terms *blastesis*, there is another which is less known, and to which he specially calls attention. The bodies which he calls *hormospores*, now described for the first time, are similar in their mode of origin to the stylospores or teleutospores of fungi. They are colourless, and contain a number of moderately large microgonidia, and are produced on the rhizines and other parts of the lichen, as the terminal cells of special hyphæ. When about to propagate, the hormospore divides into a number of cells, the microgonidia at the same time also increasing rapidly. The mother-cell then deliquesces into a jelly, the microgonidia at the same time developing into metrogonidia.

The peculiarity of lichens, which distinguishes them from every other class of vegetable productions, is that all the three kinds of tissue above described are capable of independent reproduction; but that no one of the three can itself reproduce a lichen. A combination of all three is necessary for this purpose; and this is the cause of the remarkable appearance which has given rise to the theory that a lichen is a compound structure of one organism parasitic upon another.

In a subsequent paper* the well-known lichenologist, Dr. J. Müller, of Geneva, confirms Dr. Minks's statement as to the development of the gonidia of lichens out of microgonidia. He states that he has been able to make out the microgonidia with ease, with a Swift's $\frac{1}{8}$-inch objective (a power of 360), after subjecting the lichen to the chemical treatment recommended by Dr. Minks; and with Hartnack's immersions No. 10 and No. 15 without any chemical preparation, in both fresh and dried lichens. Dr. Müller detected microgonidia in all the cells, both vegetative and reproductive, of the entire lichen; in the rhizines, cortical cells, medullary hyphæ, paraphyses, young asci, spores, basidia, and spermatia, but most distinctly in the medullary hyphæ, where they form a light greenish bead-like chain or row of minute balls in the axis of the hyphæ, with a diameter of about $\frac{1}{2000}$ to $\frac{3}{5000}$ mm. They are still more easily seen in the hyphæ of heteromerous lichens, as *Physcia* and *Parmelia;* and they can also be made out without difficulty in vertical sections through the thallus of crustaceous and foliaceous lichens. Intermediate conditions in all stages may be observed between microgonidia and gonidia, which gradually become free by absorption of the hyphæ, and then divide. Dr. Müller concludes, therefore, that the gonidia of lichens are not foreign bodies imbedded in their tissue, but that they originate in the hyphæ, as the spores in the asci.

* 'Flora,' xxxvi. (1878) 479.

After many unsatisfactory attempts with dry objectives, and inferior powers, but with some attention to chemical preparation of the material, Mr. E. Tuckerman, of the United States, says* that he has at last had the pleasure, with an immersion $\frac{1}{8}$ of Tolles, to clearly discern the pale greenish, broken column, passing into rounded, microgonidium-like masses, contained in, and seen at length to escape from, the medullary hyphæ of the *Parmelia* of Wright Lich. Cub. n. 74 (there called by him *P. tiliacea*, v. *flavicans*, and supposed the same with the *P. relicina*, at least of Montagne), reaching this result with a power of only some six hundred diameters, and without other preparation than a thorough maceration of the tissue in water. With a $\frac{1}{16}$ of Tolles, a 1-inch eye-piece, and power of about 1000, the whole structure and especially the colour, was better exhibited; as it was best of all in Tolles's admirable $\frac{1}{16}$ and $\frac{1}{25}$.

Influence of Light on Fungi.—The common idea that not only can fungi live without the influence of light, but that it is actually injurious to them, is contested by S. Schulzer, of Müggenburg,† who points out, in support of his view, the following facts. The common *Sphæria compressa* grows upon wood, originating at various depths below the surface. When it first makes its appearance, at a distance from the light, the perithecium is inconspicuous, thin, and colourless, becoming thick and dark-coloured only on exposure to light; and the same is true of several other Sphæriaceæ. *Cortinarius fulgens* and *C. cyanus* change their colour, as they mature, the one from light yellow, the other from violet, to brown, and this can be shown to be due to the influence of light, and not merely to age. Many fungi which are light-coloured and weak when buried in grass or underwood, are much more vigorous and of a darker colour when exposed to a stronger light. *Peziza Fuckeliana* always grows in an oblique direction towards the light, the stem becoming curved in a serpentine manner if its position in reference to the source of light is altered from time to time. It exhibits, in fact, a distinct positive heliotropism. Finally, a considerable number of the perennial hard Hymenomycetes belonging to the Polyporei, are able completely to develop their fructification only when freely exposed to light.

Spores on the upper side of the Pileus in Hymenomycetes.—The occurrence of a thick layer of spores on the upper side of the pileus—under circumstances where they cannot have fallen down from some other individual—has been observed in a single exotic genus of Agaricini, *Stylobates* Fr., and in several species of Polyporei, especially belonging to the genera *Polyporus* and *Boletus*. No explanation has been afforded of this singular circumstance before the recent observations of S. Schulzer.‡ In a species newly discovered by him, *Polyporus adspersus*, and subsequently in several other species, he observed that while some of the horizontal hyphæ of the pileus bend downwards towards the hymenial layer consisting

* 'Am. Jour. Sci. and Arts,' xvii. (1859) 254.
† 'Flora,' xxxvi. (1878) 119.
‡ Ibid., 11.

of the tubes on the under surface, where their extremities form the basidia and basidiospores, others bend upwards to the upper surface of the pileus, above which their delicate hyaline extremities project to the extent of from 0·025 to 0·05 mm., and then divide into two or three branches, each of which produces a spore at its extremity. In the species named, these spores resemble in every respect the ordinary purple-brown spores produced within the tubes on the under side of the pileus, while in other species they present some difference. The sporophores are usually somewhat crooked, and after producing the spores, disappear completely, leaving no trace behind, the spores alone remaining as a reddish-brown coating on the upper side of the pileus.

Change of Colour in the Spores of Fungi. — Schulzer records* a singular instance of the spores of a fungus which he considered closely allied to *Agaricus* (*Hypholoma*) *caecus*, Fr., changing their colour beneath his eyes from purple-brown to black. The observation was made while testing the correctness of Fries's statement that the colour of fungus-spores appears to vary according to the colour of the substance on which they lie, a statement he was unable to confirm.

Fungi found within the Shell of the Egg.—Dr. O. E. R. Zimmermann contributes to the 'Bericht der naturw. Gesellsch. in Chemnitz (1878) a complete history of the various fungi which induce putrefac-' tion of the egg. The attack of the fungus is sometimes indicated by small green, yellow, yellowish red, or brown spots on the shell, with internal projections into the albumen; or by yellow or greenish-yellow spots in the albumen itself, which then becomes a slate-coloured fluid, while the yolk passes into tough blackish lumps, accompanied by the offensive odour of sulphuretted hydrogen. These changes are caused by various fungi. Frequently there is found only a sterile thin-walled colourless or thick-walled olive-green mycelium, the cells of which readily separate from one another, or a mucor-mycelium (probably *Mucor racemosus*) propagating by gemmation. Among fructifying fungi, chiefly in the air-chamber at the larger end, were found *Penicillium glaucum*, *Aspergillus glaucus*, *Stysanus stemonitis*, *Echinobotryum atrum*, *Mucor stolonifer*, a *Botrytis*, and a new species, *Macrosporium verruculosum*, as well as bacteria, especially *Bacterium termo* and *Bacillus subtilis*, together with torula-cells, and others similar to those of *Oidium lactis*.†

Fungi parasitic on the Cabbage. — Under the title 'Plasmodiophora Brassicae, Urheber der Kohlpflanzen - Hernie,' ‡ Woronin publishes a treatise, illustrated with six plates, in which he describes the cause of the "club" disease so common on the root of the cabbage. It is a fungus, to which he gives the name Plasmodiophora, the simplest form hitherto known of the Myxomycetes. It consists of a minute mass of protoplasm or plasmodium, which is never enclosed within a cellulose envelope, but breaks up eventually into a great number of

* 'Flora,' xxxvi. (1878) 471.
† 'Hedwigia,' xvii. (1878) 190.
‡ 'Jahrl. f. wiss. Bot.,' xi. (1878) 548.

small spores, each of which becomes a myxamœba. These penetrate into the tissue of the root, and develop into a new plasmodium, though whether by the coalescence of a number of myxamœbæ is still uncertain. In addition to the Plasmodiophora, Woronin found in the diseased roots a new *Chytridium* (*C. Brassicæ*), propagated by zoospores. The zoosporangium has a globular base, and is elongated above into a long neck, which opens to allow the escape of the zoospores, usually outside the tissue of the host. Resting-spores were also observed, probably formed, as in other Chytridiaceæ, by the coalescence of two zoospores, though Woronin has not at present been able actually to detect this process. Similar malformations found on the roots of many other plants, especially Leguminosæ, are probably due to the attacks of fungi of the same nature.

Fungus Disease in Lettuces (*Peronospora gangliiformis*).—Referring to this subject (see page 167), MM. Bergeret and Moreau have found * that water very slightly acidulated with nitric acid constitutes a good remedy for the disease. This solution has the double advantage of being a manure for the soil, and a poison to the fungus, or at least a means of arresting its development.

Fungi of Stalactites. — Fungi play an important and hitherto unnoticed part in stalactitic distortion. In an account † of an exploration of the Luray Cavern, Virginia, U.S., Mr. H. C. Hovey says that his attention was called to numerous fine elastic bristles growing on stalactites and other kinds of dripstone in all parts of the cavern. Each carried a little ball at its extremity usually enveloped by a globule of water, and he further observed that the conditions often favoured a thin deposit of the carbonate of lime on these bristles, so that their shape remained after the substance had decayed. Many of these black setæ and white filaments were examined by the Microscope, and the gradations were traced from the finest hairs up to great knots and tangled outgrowths.

This fungus is a new species of *Mucor*, to which he gives the name of *M. stalactitis*. Sporangia globose, membranaceous, dehiscing by a fissure, terminating threads; sporidia sub-globose and separating; flocci tubular, indistinctly partitional, sometimes branching at the base, but never at the apex. Specific marks: Sub-solitary threads; sporangia simple; height $\frac{1}{10}$ to $\frac{1}{2}$ inch; colour dark olive-green.

Conidial Fructification of Fumago.—W. Zopf has written a treatise on this subject,‡ in which he showed that the conidial fructification of this fungus is obtained only when it is cultivated on a substratum of a highly nourishing character. When the supply of nutriment is deficient, three forms may be obtained; the yeast-like budding-plants, in a fluid; the mycoderma and chalara-like forms, on the surface of a fluid; and mycelial plants bearing micro-gonidia (aerial form), on a solid dry substratum. He had never, notwithstanding long trials, been able to obtain the large-spored pycnidia or the asci.

* 'Comptes Rendus,' lxxxviii. (1879) 429.
† 'Scientific American' (1879).
‡ 'Hedwigia,' xvii. (1878) 100.

Homology of the "Nucule" of Characeæ.—The female organ of Characeæ, variously termed nucule, oogonium, and archegonium, has been treated by A. Braun, Sachs, and others, as a metamorphosed shoot; whence the ordinary German appellation of "Sporensprösschen." In 'Flora' * Celakovsky gives reasons for regarding the enclosed (behüllte) oogonium, as he prefers to call it, as homologous morphologically with the globule or male organ, viz. a metamorphosed foliar structure or portion of a leaf, and consequently homologous also with the ovule of flowering plants.

Arrangement of the Cells in the flat Prothallia of Ferns.—In a series of observations on this subject, † Dr. Prantl states that the first divisions which convert a filament into a plate of cells are not determined by its position with respect to light nor with respect to gravitation; the subsequent position of the plate at right angles to the incident light being the result of torsion. In those prothallia which possess a meristem, its cells are distinguished by their smaller size, denser protoplasm, and more frequent division; these prothallia, therefore, grow more rapidly than those that are ameristic. The absence of meristem is generally the result of a deficiency either of light or of water. Archegonia are formed especially in the neighbourhood of a meristem, from cells which have just been produced from the meristem, and therefore usually arise in acropetal succession. The absence of archegonia is generally due to the want of meristem. The antheridia of ferns are, on the other hand, trichomes, and may spring from any of the older cells, and may consequently occur on ameristic prothallia. Prantl completely confirms Sachs's statement that the new division-wall is always nearly vertical to that from which it springs; and this is even the case in the wedge-shaped apical cell.

The position and extent of the meristem vary in different prothallia. In some it occupies the larger part or even the whole of the free margin, and may then be termed marginal meristem. In others it occupies only a small portion of the margin near the apex, and is then an apical meristem. This meristem passes gradually into permanent tissue, there being no sharp line of demarcation between them. A single cell of the apical meristem which possesses the merismatic property in excess, and every division of which helps to form the curve of the margin, is known as the apical cell; but it is often a matter of great difficulty to distinguish the apical cell from its neighbours. The absolute increase of the cells Prantl found to be less, the smaller the size of the cells, and consequently least in the meristem; while the increase in proportion to the size of the cell is greatest in the meristem, and sometimes greatest of all in the apical cell itself.

Apogamous Ferns and the Phenomenon of Apogamy in general.—Professor A. De Bary, in an article bearing the above title, in the 'Botanische Zeitung,' ‡ gives the results of his observations on non-sexual reproduction in ferns as first described in 1874 by Dr. Farlow.

* 'Flora,' xxxvi. (1878) p. 49 *et seq.*
† Ibid., 497.
‡ July 19th, 1878, *et seq.*

It was then shown that, in some cases, the prothalli of *Pteris cretica*, instead of the usual growth from a fertilized archegonium-cell, produced ordinary buds, from which the new fern plant developed without any sexual action whatever. The observations now published by De Bary were made with the intention of ascertaining more in detail the frequency with which the non-sexual mode of reproduction occurred in ferns, and its relation to similar processes in other groups of the vegetable kingdom.

He found, on sowing the spores of *Pteris cretica*, obtained both from cultivated plants of that species and from forms which grew wild in Italy, that, in all cases, the prothalli produced only the non-sexual buds, to which he gives the name of "Farlowsche Sprossung." In the few cases where antheridia, archegonia, and the normal embryonic development apparently occurred, he found, by watching the further development of the fern, that the prothalli were not those of *Pteris cretica*, but came from the spores of other species which had accidentally found their way into the cultures. Of the different species studied by De Bary, in thirty-four, exclusive of varieties, only the normal development by embryo-formation in the central cell of the archegonium was observed; in three, *Aspidium Filixmas* var. *cristatum*, *Aspidium falcatum*, and *Pteris cretica*, only the non-sexual budding. The prothalli of *Pteris cretica* may or may not bear antheridia. When present, they have the same structure as in the typical *Polypodiaceæ*. In by far the majority of cases there are no traces of archegonia, even in a rudimentary condition. Out of hundreds of cases, only seven were found with archegonia, and they all aborted. *Aspidium Filix-mas* perfectly resembles *Pteris cretica* in the distribution of antheridia and archegonia, but in *Aspidium falcatum* archegonia occurred in at least 25 or 30 per cent. of the prothalli. Although in the cases observed they had all aborted, De Bary thinks it possible that cases may occur in which the normal embryo-formation takes place, which is hardly possible in the two species first named.

The budding process, in all three cases, consists in the formation of a protuberance on the under surface of the prothallus, from which grow a first leaf, root, and stem-bud as in the normal embryo-formation, although their relative position and date of development vary. The protuberance is generally found just at the back of the sinus, where the fertilized archegonium normally occurs. Variations were seen in which the first leaf grew from the upper surface of the prothallus, and, at times, two leaves were produced, one on the upper and one on the lower surface. Secondary forms may be produced upon elongations of the lateral lobes of the prothallus. Some of the more peculiar forms are figured in the plate which accompanies the article. In the three species under consideration, as the normal reproduction by an embryonal growth has been lost, and another, non-sexual form of reproduction has taken its place, we may infer that they have descended from some ancestral form in which the sexual mode of reproduction existed. This is illustrated by the case of *Aspidium Filix-mas* var. *cristatum*, which is undoubtedly derived from the typical *Aspidium Filix-mas*, in which only sexual reproduction is

known. If, however, we adopt the view recently advanced by Pringsheim, that ferns were originally composed of "Bionten," some of which were sexual and some non-sexual, and which alternate more or less regularly with one another, we must consider that, instead of having acquired a new power, the ferns which reproduce by budding represent a case of atavism.

De Bary gives the name of *Apogamy* to this substitution of some other form of reproduction in cases where the power of sexual reproduction has been lost. This condition is found in all parts of the vegetable kingdom, and occurs in single species whose nearest allies reproduce normally. Apogamy is of three kinds: *apogeny*, where the function of both male and female organs is destroyed; *apogyny*, loss of reproductive power in the female, *apandry*, in the male organ.

Chara crinita is a good instance of apandry with parthenogenesis, that is of regular embryo-formation from an unfertilized ovule. The female of this species is alone known in northern Europe, yet it fruits abundantly. It has been studied by De Bary in specimens artificially grown in his laboratory; and there is no doubt that here it is not a question of the partial suppression but of the total loss of the male organs. In ferns we have the best instances of a substitution of a shoot for the normal sexual growth. To the same category belong some of the mosses usually called sterile, that is destitute of capsular growths. In the mosses, however, it is a question not yet settled whether there is a total loss or only a partial suppression of sexual reproduction.

In *Funkia* and *Allium fragrans*, in the seeds of which Strassburger discovered adventive embryos, we have something similar to the apogamous ferns; first, in the presence of apparently regularly formed but functionless female organs; secondly, in the presence of apparently active pollen; and, thirdly, in the substitution of adventive embryos for the regular embryo-formation. *Citrus* and *Cœlebogyne*, in which Strasburger also found adventive embryos, probably belong to the same class as *Allium* and *Funkia*, as may also species like *Euonymus latifolius*, many *Ardisiæ*, &c., in which polyembryony often occurs. To these are to be added the numerous species, varieties, and races of cultivated plants which rarely produce seeds, but instead have a correspondingly richer reproduction by shoots. If, as seems tolerably certain, sexual reproduction is requisite to the constant propagation of species, we must regard apogamy as a degenerate condition, in which the conditions of propagation are unfavourable. In this connection, however, we must not overlook the fact that in species with budding or non-sexual reproduction this offspring is produced in surpassing profusion.*

Apogamy in Isoetes.—The phenomenon of apogamy appears, according to the statement of K. Goebel,† to extend also to *Isoetes*. In two species, *I. lacustris* and *echinospora*, he observed, on a large number of specimens, that both macrosporangia and microsporangia

* 'Amer. Jour. Sci. and Arts,' xvi. (1878) 401.
† 'Botanische Zeitung,' xxxvii. (1879) 1.

were replaced by young plants, occupying the same position, springing, namely, from the fovea of the leaf. These were not the product of the germination of the macrospores within their sporangium, the macrosporangium being entirely suppressed. In their rudimentary stage these non-sexually produced plants are simply conical emergences, altogether resembling the rudiments of sporangia, but they gradually develop into plants with ordinary leaves. These shoots are not analogous to the bulbils which characterize many classes of vascular cryptogams, such as Lycopodiaceæ and Ferns, in which the Isoeteæ appear to be exceptionally entirely deficient, a phenomenon closely connected with the absence of branching. It is rather an instance of "apogamy" carried out to its most complete stage, namely, the complete suppression, not only of the sexual organs, but of the entire sexual generation.

MICROSCOPY, &c.

Microscopes with Swinging Tailpiece.—This addition to the Microscope has been revived within the last few years, and its novelty having been the subject of some discussion, we have referred to the provisional specification (not further proceeded with) of Mr. Thomas Grubb, at the office of the Commissioners of Patents, in July, 1854. The nature of the invention was thereby declared to "consist in the addition of a graduated sectoral arc to Microscopes concentric to the plane of the object 'in situ,' on which either a prism or other suitable illuminator is made to slide, thereby producing every kind of illumination required for microscopic examination, and also the means of registering or applying any definite angle of illumination at pleasure."

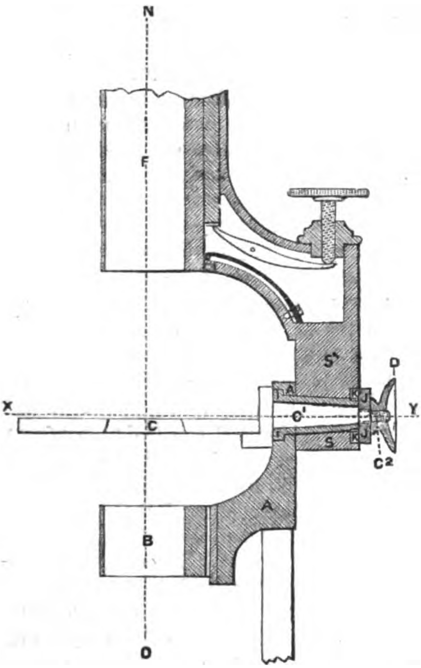
On 1st August, 1876, letters patent were granted to Mr. John Stuart (on behalf of Mr. Zentmayer, of Philadelphia) for improvements in Microscopes by means of which the sub-stage carrying the illuminating apparatus and accessories (together with the mirror if desired) and also the object stage may be placed at any required angle in relation to the optical axis of the Microscope and object-glass, and also at an angle in relation to each other for the purpose of more conveniently illuminating and viewing the object under examination, more particularly when oblique illumination is required.

The invention consists of a method by means of which the stem which carries the sub-stage and the mirror may be made to swing sideways to the right or left, either below or above the stage on a centre having for its axis of rotation a line in the plane of the object on the stage intersected by the optical axis, that is, a line passing through the centre of the body and the object-glass of the Microscope. The stage is also made to turn independently on a separate pivot, having for its axis of rotation the aforesaid line.

The figure represents in sectional elevation a portion of the Microscope.

S is the limb carrying the body with coarse and fine adjustments. A is the stem which carries the sub-stage B, and mirror if required. A is attached to S by the sleeve or socket I, clamped by the nut J,

and on I, A may be swung sideways in either direction to the right or left either below or above the stage, the axis of revolution of which is the line X Y, that is, a line in the plane of the object to be viewed on the stage C, intersected by the optical axis of the instrument, that is, the line N O, passing through the centre of the body and the



object-glass of the microscope. The stage C is also attached to S by the pin C^1, terminated by the screen C^2, which pin passes through the centre of the socket I, and turns therein so that the stage C may be made to turn in either direction in conjunction with or independent of A, the axis of its revolution being also the line X Y.

By this arrangement the stage C and the stem A may be set at an angle to the axis of the microscope either below or above X Y, intersecting the plane of the object to be viewed and also relative to each other, and when so set the stage C may be clamped at the desired angle by the nut D on the screw C^2, acting on S and the collar K.

The specification then proceeds (in the language usual in such cases):—

"Having thus particularly described and ascertained the nature of the said invention and the manner in which the same may be performed or carried into effect, I would remark that I am aware that microscopes have been heretofore made in which a stem or tail-piece has been applied so as to swing from a centre situate below the plane of the object stage, and therefore no claim is herein made in general

to a stem or tail-piece made so as to be swung in this position, but the invention which I consider to be novel and therefore desire to be secured to me by the herein in part recited letters patent, is—

"First. The making the stem A, which carries the sub-stage B, to swing to the right or to the left either below or above the stage of the microscope on a centre sleeve socket or joint I, the axis of revolution whereof is the line X Y, in the plane of the object to be viewed on the stage C, intersected by the optical axis, that is, the line N O, passing through the centre of the body F and the object-glass of the microscope, substantially as described and shown in the drawing.

"Secondly. The arrangement herein described and shown in the drawing for enabling the object-stage C to swivel or turn on a centre or pivot within the sleeve or socket I, so that the axis of rotation of the object-stage C shall be from the same centre as that on which the stem or part A turns to the right or left, and the method of clamping the object-stage C in the required angle, as herein described and shown in the drawings."

"Penetration" of Wide-angled Objectives.—It has been objected to wide-angled lenses that they possess less penetrating power, or, more properly, less depth of focus than narrow-angled lenses; that is to say, that the layer of an object, that can be seen without change of focus, is thinner with wide than with narrow-angled lenses.

Dr. Blackham, the President of the Dunkirk (U.S.) Microscopical Society, says that if this were true it would be an argument in favour of the wide-angled lenses, instead of against them; in reality, however, it does not depend upon the aperture, but is only residual spherical aberration, which can be left in and distributed in a wide-angled lens as well as in a narrow-angled one. This will be readily appreciated upon considering the action of an uncorrected plano-convex lens of crown glass. The rays from the nearer surface of the object which impinge upon the peripheral portions of the lens would, if the lens were free from spherical aberration, be brought to a focus further back than those from the further surface of the object which impinge upon the central portions of the lens. As it is, however, they are brought to the same focus, by reason of the spherical aberration. Such a lens has a good deal of *penetrating* power, or depth of focus, but its definition is not satisfactory. The same holds true of all objectives possessed of penetrating power, whatever their angular aperture. The only legitimate method of obtaining depth of focus or "penetration" is by increasing the anterior conjugate focus or frontal distance, so that the thickness of the layer that it is desired to see on each side of the true focal plane may be relatively small. Thus a 1-inch objective with an anterior focus of ·317 of an inch will bear amplification up to 400 diameters, and at that power might properly show, with reasonable clearness, a layer of the object on each side of the true focal plane much thicker than that which a one-fifth with only ·018 of an inch of anterior focus ought to show at the same amplification. It is perhaps true that, by skilful management, the residual spherical aberration can be so distributed, that several planes of an object can be in view at once; but this is always at the

sacrifice of definition, and, as the better the image the more noticeable do errors resulting from this plan of overlapping several of them become, wide-angled glasses show the defects of this plan more markedly than narrow-angled lenses, whence has arisen the fallacy that narrow-angled lenses are possessed of an inherent property of "penetration" and a residual error has been lauded as a virtue.*

Process for Measuring the Solid Angles of Microscopic Crystals.—In the 'Bulletin de la Société Minéralogique de France' (1878, No. 4, p. 68) M. Thoulet gives the following method for measuring the solid angles of microscopic crystals:—

If, in a tetrahedron, we know the lengths of the six edges, we can ascertain the angles of the faces surrounding the same summit, and can consequently resolve the spherical triangle whose sides are respectively the angles of the faces of the tetrahedron, and whose angles are the dihedral angles of the edges of this same tetrahedron.

We place the crystal (which may be isolated or contained in a thin plate of rock) in any given position under the Microscope, and choose four special points, two on the edge, and the others respectively on one and the other of the two planes whose angle is to be measured. By means of the fine adjustment of the microscope, we successively bring into focus each of these summits, and note the vertical displacement in each case by the milled head.

Without moving the crystal, we replace the eye-piece by a camera lucida, and make a drawing of the crystal, marking very accurately by pricks the position of the four points; then the crystal is replaced by a stage micrometer, which will make a scale of the drawing to be made.

We now possess all the data necessary to calculate the solid angle. Each of the sides of the tetrahedron is determined: 1st, by its horizontal projection on the drawing; 2nd, by the difference in the vertical height of its two extremities, as indicated by the fine adjustment.

The rest of the work is only a trigonometrical calculation of three rectilinear triangles, whose three sides are known, and of which one of the angles has to be found, and, finally, the calculation of a spherical triangle whose three sides are known, and one of the angles of which is to be found.

Instead of drawing the whole crystal, it is evident that it would suffice to note the four essential points; the complete drawing, however, allows a subsequent verification, which is often necessary, and, besides, enables us to decide as to the crystallographic notations to be given to the crystalline face.

The solid angles of crystals having dimensions less than $\frac{1}{100}$ of a millimetre can be measured to less than a degree by this method.†

Method of Isolating the Connective-Tissue Bundles of the Skin.—Dr. George Thin, in a paper communicated to the Royal Society,‡ describes the method he has made use of for this object.

* From a paper read by Dr. Blackham before the Indianapolis Congress. Cf. a French translation in 'Journal de Micrographie,' iii. (1879).

† 'Bull. Soc. Belg. de Micr.,' v. (1878) 6.

‡ 'Proc R. Soc.,' xxviii. (1879) 251.

By the term *bundle*, or *secondary bundle*, Dr. Thin designates the ordinary bundle of authors, which is more or less conspicuous in all preparations of skin, and which is analogous in structure and size to the bundles as usually described and figured in tendon-tissue. The element described by Rollett as "connective-tissue fibre" he describes as *primary bundle*, to distinguish it more markedly from the fibrillæ which compose it. When groups of secondary bundles are isolated, each group being composed of several secondary bundles, he terms the group a *tertiary bundle*.

These elements can be isolated by first saturating the corium with chloride of gold solution, and then macerating the tissue in acids. Portions of skin, with a thick layer of the panniculus adiposus, were taken fresh from the mamma of a middle-aged woman, which had been removed for a tumour of the gland, the portions of skin chosen being well clear of diseased tissues. The stretched skin was pinned down to a cork board, the under surface uppermost, and then saturated with ½ per cent. chloride of gold solution. From time to time different thicknesses of the fatty layer were removed as the solution had had time to penetrate into the tissue, until, finally, the deeper layer of the cutis proper was laid bare. The tissue, still extended, was then placed in fresh gold solution for several hours. The object of the manœuvre was to secure the penetration of the fluid through the bundles, whilst these were still extended in their natural condition.

After a due action of the gold, the skin was cut into small pieces, which were then treated by acetic acid, and then the strength of the acetic acid raised to 20 per cent. of the ordinary concentrated acetic acid of commerce. Other portions were treated by formic acid. Some successful preparations were obtained from portions macerated first for a few days in a mixture of one part formic acid, of specific gravity 1·020, and one of water, and then in the undiluted acid for some days longer, but a strict adherence to these strengths was not found necessary.

Portions of the corium thus prepared were teased out in glycerine and examined directly or after staining by different dyes. Staining by picric acid was found very advantageous.

In this way he was able to isolate in a condition favourable for study the primary, secondary, and tertiary bundles. Generally speaking, although not invariably, the tertiary and secondary bundles were best seen in the tissues macerated in acetic acid, and the secondary and primary bundles in those treated by formic acid.

Numerous elastic fibres were isolated by both methods, the finest fibres more particularly in the formic acid preparation.

Various methods have been recommended by histologists for the demonstration of the ultimate fibrillæ of fibrous tissue, chiefly with reference to those of tendon bundles. Judging by the figures published in histological works, the fibrillæ of the cutis bundles are, Dr. Thin thinks, very seldom seen; the appearances usually observed in skin hardened by chromic acid and alcohol are unfitted for a study of the fibrillæ. In such specimens the bundles are more or less broken up, but the individual fibrillæ are not, as a rule, isolated. He found, however, that they were well shown by the following method:—A

portion of fresh skin, with the panniculus adiposus attached, was pinned to a piece of cork in the manner already described, and treated in the same way, with the exception that this time glycerine, instead of chloride of gold solution, was used for saturation. When the saturated cutis tissue had been laid bare, the whole was placed in glycerine, and allowed to remain in it for several days. Small portions were then teased out in glycerine, stained by picro-carminate of ammonia, and examined in glycerine. In such preparations the secondary bundles were found isolated, the contours of the primary bundles not being preserved. In the secondary bundles the fibrillæ were seen more or less distinctly, in some of them with perfect distinctness.

Process for Preparing the Embryos of Fishes.—The ova of the Salmonidæ are generally employed by embryologists for the study of the development of osseous fishes. It is difficult to observe them in the fresh state, either whole, by transmitted light, on account of the thickness of their envelope, or after having opened them, in consequence of the small consistency of the germ, especially at the commencement of the segmentation. Chromic acid, the reagent most frequently employed to harden these ova, readily alters the young cells, and deforms the embryos by compressing them between the unextensible envelope of the ovum and the solidified vitelline mass. For the last two years M. F. Henneguy * has employed, in the laboratory of comparative embryogeny of the College of France, a process which allows the germs and embryos to be extracted from the ova of Trout and Salmon with the greatest facility, and without subjecting them to the least alteration.

He places the ovum for some minutes in a 1 per cent. solution of osmic acid until it has acquired a light brown colour; then in a small vessel containing Müller's liquid, and opens it in this liquid with a pair of fine scissors. The central vitelline mass, which is coagulated immediately on contact with water, dissolves, on the contrary, in the Müller's liquid, while the solidified germ and cutical layer may be extracted from the ovum, and examined upon a glass plate.

By treating the germ with a solution of methyl-green, and then with glycerine, Mr. Henneguy was able to observe in the cells of segmentation the very delicate phenomena lately pointed out by Auerbach, Bütschli, Strasburger, Hertwig, &c., and which accompany the division of the nucleus, namely, the radiated disposition of the protoplasm at the two poles of the cell, the nuclear plate, the bundles of filaments which start from it, and the other succeeding phases.

This fact proves that the treatment undergone by the ovum does not in any way alter the elements of the germ.

To make cross sections of the germs and embryos thus extracted from the ovum, they should be left for some days in Müller's liquid, and coloured with picro-carminate of ammonia. After having dehydrated them by treating them with alcohol of spec. grav. 0·828, and then with absolute alcohol, they are put for twenty-four hours into collodion. The embryo is then placed on a small plate of elder-pith

* 'Revue Internat. des Sci.,' iii. (1879) 150.

soaked with alcohol, and covered with a layer of collodion. When the collodion has acquired a sufficient consistency, very thin sections may be made, comprising both the embryo and the plate of pith; and these are to be preserved in glycerine. If the sections cannot be cut directly, the piece is placed in the 40 per cent. alcohol; the collodion then preserves its consistency, and allows the embryo to be cut at any time.

This process is applicable to every kind of embryo of little thickness, allowing it to be coloured *en masse*. It has the immense advantage of enabling one to see at what level of the embryo each section is made, to preserve it in the middle of a transparent mass, which maintains all the parts, and prevents their being damaged, as very often happens when an inclusory mass is employed, from which the section must be freed before mounting it.

In his 'Précis de Technique Microscopique' M. Mathias Duval has already recommended collodion for embryological researches, but without indicating his mode of employing it. We hope to render a service to embryologists by making known a process which may be of some utility.

Improvement in Aerating Apparatus of Sea-water Aquaria.—Dr. H. Lenz, of Lübeck, has employed with success the following method (suggested to him by Mr. A. Sasse, of Berlin) for producing very minute air-bubbles from the aerating apparatus. The aperture of the glass tube, instead of being drawn out into a fine point, is widened to 6–8 mm., or a glass tube 25 mm. long and 6–8 mm. wide is cemented with sealing-wax on to the short discharging arm. A piece of common sponge is then pressed pretty tightly into the wide opening. Instead of the somewhat large single air-bubbles, we then have hundreds of very small ones in clusters, and the tighter the sponge is pressed in, the smaller they become.

By this means the air is as finely divided as by the syringe apparatus of the large aquaria. Very slight, if any, increase of pressure is found necessary; and should in time algæ, &c., become attached to the sponge, it can easily be taken out and cleansed. Dr. Lenz used his sponge for three months before it wanted cleaning.*

Further Improvements in studying the Optical Characters of Minerals.—Mr. H. C. Sorby has lately improved his method of studying the optical characters of minerals. He says:†—

"It is a curious example of how a method may be invented and then lost sight of, that the determination of the index of refraction in the way I have previously described, was proposed by a French savant upwards of a hundred years ago. I have not yet consulted the original publication, but I very strongly suspect that the proposal was more theoretical than practical, and that with the instruments then at disposal the results were found to be so inexact that the whole system became obsolete and practically forgotten. I may, however, claim to have so modified the method, and brought the instrumental means to

* 'Zool. Anzeiger,' ii. (1879) 20.
† 'Mineralogical Magazine,' ii. (1878) 103.

such perfection, as to make it fully equal to the requirements of practical mineralogy. Whilst speaking on this point, it may be well to give an illustration of the accuracy with which it is possible to measure the index with the apparatus which I have now at disposal. Thus, in the case of a specimen of quartz, about ·372 inch thick, five different determinations of the index of the ordinary ray for the light transmitted by red glass, which corresponds to the solar line *c*, were 1·5513, 1·5531, 1·5524, 1·5531 and 1·5513, so that no observation differed more than a unit in the third place of decimals from the mean value, which may therefore be looked upon as true to the third place of decimals, assuming that the equation $\mu = \frac{T}{T - d}$ needs no correction.

There was no difficulty in thus proving that there is a slight but well-marked difference in the index for different specimens. The mean for five was 1·5543, whereas, according to Rudberg, it is 1·5418. In a similar manner I found that my method invariably gave too high a result in the case of other minerals. After many careful measurements I came to the conclusion that this can be satisfactorily attributed to the spherical aberration due to the introduction of a transparent plate in front of the object-glass, as suggested by Professor Stokes. The amount of this error depends partly on the index of refraction, and partly on the special correction of each particular object-glass; and when great accuracy is desired, it is necessary to construct a small table showing the amount that must be deducted in each case. I thus find that, when using my ⅗ object-glass, if the index is about 1·5 I must deduct ·0100, and when 2·0, must deduct ·0180.

Having thus shown how accurately the index may be measured, it may be well to briefly allude to some improvements in the apparatus. I find two cross lines in the focus of the eye lens very useful in keeping constant the focal adjustment of the eye itself. In adjusting the focus of any object it is always arranged so that the cross lines are also in sharp focus. Without this precaution there may be an important difference, according as the focus is adjusted by moving the object-glass up or down. I have also found it desirable to take the means of two or more sets of measurements made in slightly different parts of the scale, so as to eliminate any error due to imperfect graduation. This is easily managed by moving the fine adjustment. It is by adopting these precautions that I have been able to make such concordant and accurate measurements as those given above in the case of quartz, and to prove that the limit of error may be made very small.

When first I commenced to apply my method to the study of various minerals, with the view of comparing mathematical theory with observation, I soon found that there were a few discrepancies. For some time I thought it just possible that these might be due to errors in the measurements, but I found that these discrepancies became the more and more marked as by degrees I was able to remove every apparent source of error. The principal discrepancy is in the case of bi-axial crystals like aragonite, but some are also met with in

the case of uniaxial crystals. I have not yet been able to thoroughly ascertain the laws which govern these special peculiarities, and no kind of explanation has yet suggested itself either to Professor Stokes or myself; and therefore it appears to me undesirable to enter more fully into the question, which relates more to the mathematical theory of light than to practical mineralogy. It may, however, be well to say that the discrepancy to which I refer is in the ratios of the values of the real and apparent indices."

Mr. Sorby gives an illustration of the application of the method to the identification of doubtful minerals, in the case of certain crystals, which he determined to be an unusual secondary form of calcite.

Improved Achromatic Condenser.—Messrs. R. and J. Beck have introduced a modification of the achromatic condenser, in which a series of combinations of lenses are made to revolve excentrically, so as to be brought consecutively into combination with a lower fixed series of lenses. The apertures vary from 40° to 170°, and two of the revolving combinations are truncated and blackened, so as to stop out the central rays to the limits of 60° and 120°.

The latest addition to the instrument consists of the application of a revolving diaphragm, with various sized apertures beneath the entire combinations.

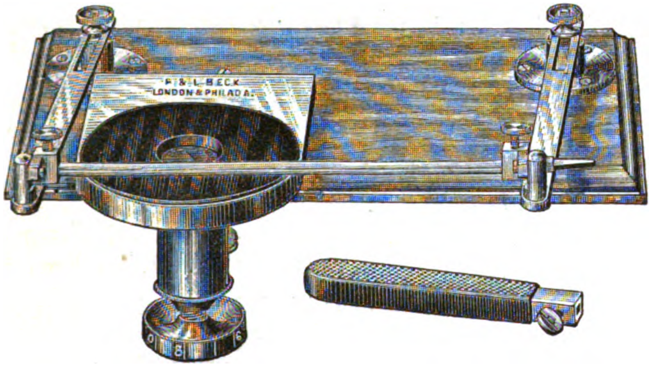
Seiler's Mechanical Microtome.—Dr. Carl Seiler, of Philadelphia, is the inventor of an apparatus for enabling the knife, in cutting sections, to be carried through the tissues with an even motion and at the same inclination—a necessary point to ensure success, but not so easy as might be imagined, because the hands usually are not sufficiently steady without a great deal of practice.

It occurred to Dr. Seiler, therefore, that if the knife could be rigidly fastened to some apparatus by means of which it could be moved over the well of the microtome in the same manner that the hands move it, sections of any size and thinness could easily be made, even by an unpractised hand; and after some experimenting he constructed, with the aid of Mr. Zentmayer, a mechanical microtome which proved to be all that could be desired.

It consists of two rigid, parallel arms of metal, which at one end revolve on pivots attached either to the microtome itself, or to the table to which the microtome is to be clamped. On the other end of these arms are fastened revolving clamps which hold the knife, the edge of which, when in position, rests upon the glass plate of the microtome. The handle of the knife is removed, so as to prevent a slipping and hindrance to the motion of the knife, but can be easily attached by means of a screw, for the purpose of stropping.

When in position and ready for cutting, the knife is pressed upon the glass plate, and a slight side-motion is given to it by the hands, which causes it to pass through the tissue, and cut a thin, even section without difficulty. With this apparatus he was able to cut a thin section of the leg of a five months' fœtus, from the knee downward, including the foot, the section measuring 2 inches in length by ¾ inch in width. Several mechanical microtomes have been constructed by

various workers, but to his knowledge they are all deficient in one point, viz. the knife or cutting instrument in them is carried through the tissue like a chisel; or, in other words, the cutting edge is pressed through the tissue. But a knife, in order to cut well and evenly,



must be carried through the substance to be cut, especially if it is soft, in a slanting direction, so that each point of the edge describes a curve which is equal to a part of a circle. By referring to the figure it will be seen that in Dr. Seiler's apparatus this is exactly what takes place when the knife is moved, the radius of the curve being the length of the arms from the centre of the clamps to the centre of the pivots.*

Size of Histological Preparations.—Dr. Seiler, in the same article ("Practical Hints on Preparing and Mounting Animal Tissues"), considers that the advantage of having the sections of sufficient size to bring into view the different parts of which it is composed has not as yet received sufficient attention from microscopists, especially from those engaged in the study of pathological histology, and yet it is of the greatest importance, for very frequently a pathological new growth will present different appearances in different parts, and often an erroneous conclusion is arrived at in regard to the nature of the tissue from the fact that but a small section has been examined.

"Microscopy" and "Microscopical" Societies.—Under the title of "Is there a Science of Microscopy?" we gave at page 365 of vol. i. an extract from an article by the Editor of the 'American Quarterly Microscopical Journal,' and stated our intention of adding in a later number a translation of an article by Dr. Kaiser, the Editor of the Berlin 'Zeitschrift für Mikroskopie.' This intention we are obliged to abandon, as we find it impossible to do justice to the author's views within reasonable limits of space, the article occupying twenty-five pages of the German Journal. It must suffice here to say that Dr. Kaiser, after referring to Professor Harting's protest against the use of the word Microscopy, and his attempt to contrast it with Ophthalmoscopy ("the science of observation with

* 'Amer. Quart. Micr. Journ.,' i. (1879) 134.

the naked eye"), defines the former as "a free independent scientific discipline of the natural sciences," and "claims the elementary forms as the original and peculiar domain of special Microscopy."

It seems to us, with all deference to those who have from time to time laboured to define "Microscopy" as some special branch of Biology, that they have been led to a fallacious result, through a preconceived idea as to what it would be convenient for the definition to be.

There is, we think, no need to object to "Microscopy" being limited to the Microscope as an instrument (the methods of its application as well as its principles), and the hesitation to admit this has apparently arisen on account of objections that it was thought would then be urged against the existence of a "Microscopical" Society, to which objections, however, there are obvious answers.

The first is, that a "Microscopical" Society, if "Microscopy" refers only to the instrument, is equivalent to a "Lancet" or a "Theodolite" Society.

Even if a Society were established for the single purpose of dealing with the Microscope as an instrument, it would not by any means stand on the same footing as the Lancet or the Theodolite. The Microscope is an instrument *sui generis*, and is not comparable with any other. It is not only as regards its optical principles and mechanical form, but in the various methods of its application, that it might usefully furnish scope for a Society devoted only to those points without regard to any others.*

But further, it is an entire misapprehension if it is supposed that the objects of any known Microscopical Society of the present day are confined to the Microscope as an instrument. The objects of this Society in particular have always been twofold, and have included to an equal extent, to say the least, those branches of natural science conveniently summarized as "the subjects of Microscopical research."

The term "Microscopical," which, as applied to a Society, was no doubt originally used in a sense more nearly agreeing with its strict etymological meaning, has come to be no more than a sign and a symbol, as much as the title of 'Lancet' applied to a newspaper, or those of "Royal" or "Linnean" to a Society.

When this first objection is thus answered, it is then said that another Society for the investigation of subjects of natural history is not required.

It must, however, be obvious that if fifty or twenty-five years ago the Royal Society and the Linnean Society were sufficient to meet the requirements of the biology of that day, the great advance that has been made since that time, and the enormous extension in the ground to be travelled over, is sufficient to justify the existence not of one but of several additional Societies. Notwithstanding that there were

* The most recent instance of the practical benefit to be derived from abstract optical (Microscopical) principles is to be found in the oil-immersion objectives (the origination of which is due to the Treasurer of this Society, Mr. Stephenson), and which are the outcome of the highly technical, and to the biologist no doubt extremely uninteresting discussions on angular aperture, but which have put into his hands a tool which is admitted to mark a greater improvement in the means of investigation than any made since the perfecting of achromatic objectives.

older Societies which covered the same ground, there has been found to be room for another mainly devoting itself to the larger animals—the Vertebrata, and in the same way there was obviously room for one mainly devoting itself to the smaller animals—the Invertebrata, and to the development and minuter structure of the higher forms.

We therefore should define "Microscopy" as the science and art of the Microscope as an instrument both in regard to its theoretical principles and its practical working; but a "Microscopical" Society, as a Society established on the one hand for the improvement of the Microscope and the methods of its application ("Microscopy" proper), and also for the communication of observations and discoveries in the various branches of Biology (Invertebrata, Cryptogamia, Embryology, Histology, &c.), which more especially require the aid of the Microscope for their investigation.

Oil-Immersion Objectives.—We are glad to find that the English opticians are at length turning their attention to these objectives, which it has hitherto been impossible to procure of English manufacture, although we believe we are correct in saying that their construction was primarily urged upon opticians in this country when the idea first suggested itself of the desirability of oil objectives.

Messrs. Powell and Lealand exhibited at the meeting of the Society on the 9th April, an $\frac{1}{8}$ oil-immersion objective of their manufacture, and we believe that the construction of higher powers is being proceeded with.

Method of Preserving Infusoria, &c.—A note by M. A. Certes in 'Comptes Rendus'* describes a method of obtaining permanent preparations of the Infusoria, which he hopes may help to create collections of which all the Museums of Europe are at present deficient.

The method which he suggests is the employment of the vapour or a solution of osmic acid (2 per cent.), the former, although well known in histology, "never yet having been applied to the Infusoria,"† and he claims that the organisms are instantaneously fixed, so that the least details, cilia, cirrhi, flagella, and buccal armature may be observed with the highest powers, the Euglenæ and Paramecia preserving their characteristic colour. The nucleus and nucleolus stand out clearly, and show, when these occur, the curious phenomena described by Balbiani. The process may be applied successfully not only to the Infusoria, but also to the Rotatoria, Anguillulæ, Bacteria, and Vibrions.

The important point is to make the osmic acid act promptly and with a certain force. Two means are available for obtaining this result with some certainty. The first, which is suitable for most cases, consists in exposing the Infusoria to the vapours of the acid for a period of from ten to thirty minutes. For very contractile Infusoria the process is different, the immediate contact of the osmic acid being obtained by putting a drop of the solution on the cover-glass before placing the latter on the drop of water. The excess

* 'Comptes Rendus,' lxxxviii. (1879) 433.

† Compare, however, Dr. Pelletan's process—this Journal, i. (1878) 189. Also Huxley and Martin's 'Biology.'

of liquid is then removed by blotting-paper, and thereby a slight and advantageous pressure produced on the cover-glass.

After the cover-glass is in place, two of the opposite sides should be fastened either with paraffin or Canada balsam to prevent displacement in colouring.

To colour the organisms he uses eosin or Ranvier's picro-carminate. Infusoria previously treated with the osmic acid may be coloured direct with the picro-carminate, but when it is employed alone, it is not easy to control the colouring, so that the preparations often turn out opaque. After several attempts, he found that a mixture of glycerine and picro-carminate will enable any degree of colour to be obtained (glycerine 1 part, water 1 part, picro-carminate 1 part). Introduced suddenly, the glycerine even when diluted frequently produces an abnormal retraction of the tissues, which does not always disappear. Professor Ranvier gives in his 'Histology' a very simple means of avoiding this inconvenience, which M. Certes has employed with success for the most delicate organisms, such as *Oxytricha* and *Stentor*; it consists in placing the preparations, fastened as above described, in a moist-chamber, and putting a drop of carminated glycerine on the edge of the preparation. The water evaporates very slowly, and in twenty-four hours is replaced by the diluted glycerine. By the same process the latter may be replaced by concentrated glycerine, which assures the preservation of the preparations.

All methods of sealing down may be applied. It is, however, better to use dry Canada balsam dissolved in chloroform. The organism to be examined might be at the side of the glass, and this varnish, being thin and perfectly transparent, does not hinder observation even with the highest powers.

Mixture of Oils for Homogeneous-Immersion Objectives.—Professor Abbe points out that in regard to the performance of oil-immersion lenses with *central* light it is a matter of importance to regulate carefully the oil-mixture as regards refraction and dispersion. He noticed some time ago that some of the samples of fennel-oil and olive-oil were rather strong in both respects, so that it is possible that better performance will be got with central illumination when a small additional quantity of olive-oil is added for reducing the refraction to that of the oil of cedar-wood, and then further adding $\frac{1}{3}$ or $\frac{1}{2}$ of cedar-oil to the mixture to reduce the dispersion (the latter specially for thin covers).

New Fluids for Homogeneous Immersion. — The result of Professor Abbe's later experiments will be found at p. 346 of the 'Proceedings.'

Standard Micrometers.—A letter from Professor R. Hitchcock (the editor of the 'American Quarterly Microscopical Journal') on this subject is printed at p. 349 of the 'Proceedings.'

Unit of Micrometry.—The resolution come to by the meeting of the Society on the 9th April will be found at p. 349 of the 'Proceedings.'

OBITUARY.*

SEVEN Fellows have died during the past year, viz.:—Mr. R. J. Bagshaw (London), elected 1846, died 14th August, 1878; Mr. R. Branwell, M.R.C.S. (Brighton), elected 1873, died 23rd September, 1878; Dr. H. Owens, M.D., M.R.C.S. (London), elected 1867, died 9th September, 1878; Captain E. W. Roberts, F.R.G.S. (Boxmoor), elected 1866, died 12th June, 1878 (of whom we have not received any Obituary Notices); and the following:—

Mr. JOHN ROBERT BURTON (a successful merchant, and one of the founders of the "British Empire Life" and "Perpetual Building Society," on the management of which he continued to the last) died at his residence, Huskards, Ingatestone, on the 20th November, 1878. He was elected a Fellow of the Society in 1861, and though rarely seen at the meetings, was much attached to the use of the Microscope, and occupied himself in his leisure hours with mounting objects.

Mr. GEORGE GUYON was a descendant (the great-grandson) of the famous French Huguenot family of Guyon; the head of which, Guyon de Geis, Sieur de Pampelona, came over to England at the Revocation of the Edict of Nantes, and took service under William III. He was born at Richmond, in Surrey, on March 10th, 1824, after the younger of the senior members of his family had grown up. One of these, General Guyon, became famous subsequently for his defence of Kars (in conjunction with Sir Fenwick Williams) against the Russians.

From his birth Mr. Guyon was so delicate as to preclude the possibility of his being educated for any profession. He very early exhibited the strongest predilection for science, and especially for natural science, devoting himself at one period of his life largely to Entomology. He leaves an extensive and valuable collection of Coleoptera. He later took up the Microscope enthusiastically, and became an expert and dexterous manipulator. His neatness in mounting objects was remarkable, and he had accumulated a large number of specimens illustrative of various branches of natural history. By his physician's order, he was for some years compelled to pass the winter at Ventnor, which he ultimately made his permanent residence, and where he erected an astronomical observatory, furnished with a fine equatorial, &c.

There were few more delightful men in society than Mr. Guyon. His varied and extensive reading supplied an inexhaustible fund of conversation; while his numerous accomplishments, and unflagging readiness to enter into any scheme of amusement or instruction, rendered him a favourite both with old and young. Nor was his pen idle. He contributed, *proprio nomine*, and under his initials "G. G.," pretty frequently to 'Science-Gossip'; appearing at other times as "Vectensis" in the 'English Mechanic.' Lastly, he was a munificent anonymous donor to nearly all the leading charities in England.

* Pressure on our space made it necessary to omit this in the last number. It should have accompanied the Report of the Council.

He was elected a Fellow of this Society in 1858, and died 25th February, 1878, in his fifty-fourth year.

Dr. Edward James Shearman, M.D., F.R.S.E., F.L.S., &c., who died at Rotherham on the 2nd October, 1878, in his eighty-first year, was born at Wrington, in Somersetshire, next door to the celebrated Hannah Moore, and received his early education at Mr. Catlow's School, at Mansfield, where he was articled to a surgeon. He passed the Apothecaries' Company in 1820, having had the opportunity of studying under Brodie (afterwards Sir B. C. Brodie), at St. George's Hospital, and settled at Rotherham about 1823, where he very soon took a leading position as a general practitioner in the town and neighbourhood. He afterwards passed the College of Surgeons, and some ten years ago was made a Fellow. He took the degree of M.D. of Jena in 1841, and became a Member of the Royal College of Physicians, London, in 1869, having obtained the extra Licentiate in 1843.

His contributions to medical literature have been numerous and varied in almost all the journals of his time. In 1845 he published an "Essay on Properties of Animal and Vegetable Life." In 1846 he was elected one of the Council of the Provincial Medical Association, and in 1847 was appointed to write the "Retrospective Address on Diseases of the Chest," which was read by his son in 1848 at the annual meeting, and was afterwards published by the Council. He was elected a Fellow of the Royal Society of Edinburgh, of the Medico-Chirurgical Society, and of several other learned bodies. In 1856 he was elected a Fellow of this Society, having been early associated with the pioneers of the Microscope in medicine, and he continued to the last to manifest a most striking love for microscopical science, in diagnosis of disease, of which he had early become an adept. More than twelve months before Dr. Golding Bird published his first edition of 'Urinary Deposits,' he read before the Sheffield Medico-Chirurgical Society an "Essay on the Changes in the Urine affected by Disease," and the tests to distinguish them, which was published in the 'Lancet'; and the information which he gave to the town on sanitary matters was very interesting, exposing the evils which existed at the time, which attached more particularly to bad water and faulty drainage. His microscopical examinations of the water caused great alarm, and thoroughly opened the eyes of the people to the unsanitary condition of the town as regarded sewage and water, and paved the way for a new and better era.

He was married twice, first to the daughter of Mr. Brooks, of Old Moor, Wath, by whom he had three children; the death of his surviving son, Dr. Charles, who died about fourteen years ago, aged fifty, was a great blow to him, as he was a man of acumen and great promise in his profession. In 1872 he was married to Miss Turner, of South Grove, who survives him. Dr. Shearman was held in the highest esteem by large numbers, not only of friends, but of patients in various parts of the country, who had been in the habit of constantly consulting him.

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Zittel, K. A.—Studies on Fossil Sponges. III., IV., V., Monactinellidæ, Tetractinellidæ, and Calcispongiæ. *Ann. & Mag. Nat. Hist.*, III., No. 16.

Cœlenterata.

Chun, Dr. C.—The Nerve System and the Musculature of the Ctenophora. (2 plates.) *Abh. Senckenb. Nat. Gesell.*, XI., Parts 2 & 3.

Ciamician, J.—On the Minute Structure and the Development of *Tubularia mesembryanthemum*, Allman. (2 plates.) *Zeitschr. f. Wiss. Zool.*, XXXII., Part 2.

Eimer, T.—The Medusæ. Physiological and Morphological Researches on their Nervous System. (13 plates and 31 figs.) (4to. Tübingen, 1879.)

Higgin, T., F.L.S.—Notes on the Polypidom or Skeleton of the Hydractinidæ. *Proc. Lit. & Phil. Soc., Liverpool*, XXXII.

Klunzinger, Dr. C. B.—The Coral Animals of the Red Sea. Vol. II. The Stone Corals. 1. The Madreporidæ and Oculinidæ. (8 phot. and 2 plates.) (4to. Berlin, 1879.)

Matthews, J., M.D., F.R.M.S.—On the History and Structure of Corals. (1 plate and 1 fig.) *Journ. Quek. Micr. Club*, No. 39.

Pourtalès, L. F. de.—(Reports on the results of Dredging in the Gulf of Mexico by the U.S. Coast Survey steamer 'Blake.')—Report on the Corals and Crinoids. (2 plates.) *Bull. Mus. Comp. Zool. Camb.*, V., No. 9.

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Schultze, F. E.—[*Note on*] '*Spongicola fistularis*, Hydrozoon inhabiting a Sponge.' *Arch. Zool. Expér. & Gén.*, VII., No. 2.

Studer, Prof. Th.—[*Note on*] 'The Siphonophora of the Deep Sea.' *Arch. Zool. Expér. & Gén.*, VII., No. 2.

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Agassiz, A.—(Reports on the results of Dredging in the Gulf of Mexico by the U.S. Coast Survey steamer 'Blake.') Report on the Echini. (2 figs. and 5 plates.) *Bull. Mus. Comp. Zool. Camb.*, V., No. 9.

Lyman, T.—(Ditto, ditto), Report on the Ophiurans and Astrophytons. (3 plates.) *Bull. Mus. Comp. Zool. Camb.*, V., No. 9.

Pourtalès, L. F. de.—(Ditto, ditto), Report on the Corals and Crinoids. *Bull. Mus. Comp. Zool. Camb.*, V., No. 9.

Carpenter, P. Herbert, M.A.—On the Apical and Oral systems of the Echinodermata. II. *Q. Journ. Micr. Sci.*, XIX., No. 74.

Jullien, Dr. J.—Description of a New Genus of Stelleridæ of the Family of the Asteriadæ. *Bull. Soc. Zool. France*, III., Nos. 3 & 4.

Lang, Major.—On the Ambulacral Suckers and Pedicellariæ of *Echinus miliaris.* (5 figs.) *Sci. Gossip*, No. 172.

Lyman, T.—Ophiuridæ and Astrophytidæ of the exploring voyage of H.M.S. 'Challenger.' Part I. (10 plates.) *Bull. Mus. Comp. Zool. Camb.*, V., No. 7.

PERRIER, E.—Study of the Geographical Distribution of the Asteriadæ. *Nouv. Arch. Mus. Hist. Nat.*, I., Part 1.

REPORT of the Commission on the Serres Prize, awarded to Prof. A. Agassiz for his Researches on the Embryology of the Echinodermata and Fishes. *Comptes Rendus*, LXXXVIII., No. 10.

VIGUIER, Dr. L.—Comparative Anatomy of the Skeleton of the Stelleridæ (*concluded*). (8 plates.) *Arch. Zool. Expér. & Gén.*, VII., No. 2.

Vermes.

CORNU, MAX.—On a New Disease which destroys the Rubiaceæ of Hothouses (Anguillulæ). *Comptes Rendus*, LXXXVIII., No. 12.

Cosmovici, L. C. E.—On the Segmental Organs and Genital Glands of the Sedentary Polychætal Annelids. (Translated from 'Comptes Rendus.') *Ann. & Mag. Nat. Hist.*, III., No. 16.

GALEB, Dr. O.—Researches on the Entozoa of Insecta. Organization and Development of the Oxyurida. *Arch. Zool. Expér. & Gén.*, VII., No. 2.

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Megnin P.—New Observations on the Development and Metamorphoses of the Tape-Worms. (Translated from 'Comptes Rendus.') *Ann. & Mag. Nat. Hist*, III., No. 16.

VEJDOVSKY, Dr. F.—Contributions to the Comparative Morphology of the Annelida. I. Monograph of the Enchytraeidæ. (14 plates.) (4to. Prague, 1879.)

Arthropoda.

GRENACHER, H. — Researches on the Visual Organs of the Arthropoda, especially Arachnida, Insecta, and Crustacea. (11 plates.) (4to. Göttingen, 1879.)

α. *Crustacea.*

DAVIES, J., F.R.M.S.—A chapter on Fish Parasites. (3 figs.) *Sci. Gossip*, No. 172.

HESSE, M.—Description of Crustacea rare or new to the French Coast. No. 28. (1 plate.) *Ann. Sci. Nat. (Zool.)*, VII., Nos. 5 & 6.

HUXLEY, T. H., Sec. R.S., V.P.Z.S.—On the Classification and the Distribution of the Crayfishes. (7 figs.) *Proc. Zool. Soc.*, 1878, No. 49.

β. *Arachnida.*

BUTLER, A. G., F.L.S., F.Z.S., &c.—Description of a remarkable New Spider from Madagascar. (3 figs.) *Proc. Zool. Soc.*, 1878, No. 49.

FAXON, WALTER.—On the Presence of *Demodex folliculorum* in the Skin of the Ox. (1 plate.) *Bull. Mus. Comp. Zool. Camb.*, V., No. 2.

GEORGE, C. F.—On the Mite of the Humble Bee Gamasus. (3 figs.) *Sci. Gossip*, No. 172.

SIMON, E.—Description of a new Genus of the Family of the Cheliferidæ. *Bull. Soc. Zool. France*, III., Nos. 1 & 2.

SLATER, H. H., B.A., F.Z.S.—On a new Genus of Pycnogon, and a variety of *Pycnogonum littorale* from Japan. *Ann. & Mag. Nat. Hist.*, III., No. 16.

γ *Myriapoda.*

MOSELEY, H. N., F.R.S.—Notes on the Species of *Peripatus*, and especially on those of Cayenne and the West Indies. *Ann. & Mag. Nat. Hist.*, III., No. 16.

δ *Insecta.**

CHAUDOIR, Baron DE.—Descriptions of new Genera and unedited Species of the Family of the Carabidæ. *Bull. Soc. Imp. Nat. Moscow*, LIII., No. 3.

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* See note on p. 272.

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Dallas, W. S., F.L.S.—Entomology. *Pop. Sci. Rev.*, III., No. 10.

Darwin, C.—Fritz Müller on the Abortion of the Hairs on the Legs of certain Caddis-flies, &c. (2 woodcuts.) *Nature*, XIX., No. 490.

Forel, Dr. Auguste.—Myrmecological Studies in 1878 (first part) with the Anatomy of the Gizzard of Ants. (1 plate.) *Bull. Soc. Vaud. Sci. Nat.*, XV., No. 80.

Fowler, Rev. W. W., M.A.—Notes on Coleoptera, &c. *Mid. Nat.*, II., No. 16.

Hagen, Dr. H.—The Natural History of the Gall-making Cynipidæ (from the Canadian Entomologist). *Scot. Nat.*, V., No. 33.

Higgins, Rev. H. H.—On the Appendages of a rare Coleopterous Insect belonging to the family of the Dynastidæ. *Proc. Lit. & Phil. Soc. Liverpool*, XXXII.

Hunter, J.—On the Queen Bee, with special reference to the Fertilization of her Eggs. *Journ. Quek. Micr. Club.*, No. 39.

Jones, E. D., C.E.—Experiment with a Venomous Caterpillar. (1 plate.) *Proc. Lit. & Phil. Soc. Liverpool*, XXXII.

Mabille, P.—Lepidoptera Africana. *Bull. Soc. Zool. France*, III., Nos. 1 & 2.

Moncrieffe, Sir T., Bart.—The Lepidoptera of Moncrieffe Hill (*concluded*). *Scot. Nat.*, V., Nos. 33 & 34.

Perez, Prof. J.—Memoir on the Oviposition of the Queen Bee and the Theory of Dzierzon. *Ann. Sci. Nat. (Zool.)*, VII., Nos. 5 & 6.

Sanson, Prof. A.—Note on Parthenogenesis in Bees. *Ann. Sci. Nat. (Zool.)*, VII., Nos. 5 & 6.

Service, R.—The Aculeate Hymenoptera of the District surrounding Dumfries. *Scot. Nat.*, V., No. 34.

Sharp, D., M.B.—Insecta Scotica.—The Coleoptera of Scotland. *Scot. Nat.*, V., No. 33.

White, F. Buchanan, M.D., F.L.S.—Insecta Scotica.—The Lepidoptera of Scotland (*continued*). *Scot. Nat.*, V., No. 33.

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Waters, A. W., F.G.S.—On the Bryozoa (Polyzoa) of the Bay of Naples. (2 plates.) *Ann. & Mag. Nat. Hist.*, III., No. 16.

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Bertin, V.—Revision of the Tellinidæ of the Museum. (2 plates.) *Nouv. Arch. Mus. Hist. Nat.*, I., Part 2.

Dall, W. H.—Preliminary Report on the Mollusca of the U.S. Coast Survey (Steamer 'Blake') Expedition. *Bull. Mus. Comp. Zool. Camb.*, V., No. 6.

Jousseaume, Dr. F.—Malacological Fauna of the Environs of Paris (Nos. 6 & 7).

„ „ Malacological Excursion through the Exhibition of 1878. *Bull. Soc. Zool. France*, III., Nos. 1–4.

Marratt, F. P.—List of Shells from Fuca Straits and Cape Flattery. *Proc. Lit. & Phil. Soc. Liverpool*, XXXII.

Nikitina, S.—*Amaltheus funiferus* Phill. (2 plates.) *Bull. Soc. Imp. Nat. Moscow*, LIII., No. 3.

Owen, Prof., C.B., F.R.S., F.Z S., &c.—On the Relative Positions to their Constructors of the Chambered Shells of Cephalopods. (1 plate and 5 figs.) *Proc. Zool. Soc.*, 1878, No. 49.

Prime, T.—Description of a new Species of *Corbicula*, with Notes on other Species of the Corbiculadæ Family. (1 plate and 1 fig.) *Bull. Mus. Comp. Zool. Camb.*, V., Nos. 4 & 5.

„ „ Notes on the Anatomy of Corbiculadæ (Mollusca), &c., and a translation from the Danish of an article on the Anatomy of *Cyclas* (*Sphærium*), by Jacobsen. (1 plate.) *Bull. Mus. Comp. Zool. Camb.*, V., Nos. 4 & 5.

Simroth, Dr. H. —The Movement of our Land Pulmonata, with special reference to the Foot of *Limax cinereoniger* Wolf. (2 plates.) *Zeitschr. f. Wiss. Zool.*, XXXII., Part 2.

Warren Amy.—The Land and Fresh-water Mollusca of Mayo and Sligo. *Zoologist*, III., No. 25.

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A. GENERAL, INCLUDING EMBRYOLOGY AND HISTOLOGY OF THE PHANEROGAMIA.

Behrens, W. J.—The Nectaries of Flowers (*continued*). (3 plates.) *Flora*, LXII., Nos. 4 & 6.

Brunton, T. Lauder, M.D., F.R.S., and Walter Pye (see Zoology A.).

Chamberland, Ch.—Resistance of the Germs of certain Organisms to a Temperature of 100°; Conditions of their Development. *Comptes Rendus*, LXXXVIII., No. 12.

Elfving, F.—Studies on the Pollen-grains of the Angiosperms. (3 plates.) *Jen. Zeitschr. f. Nat.*, XIII., Part 1.

Gilburt, W. H.—On the Floral Development of *Helianthus annuus*. (1 plate.) *Journ. Quek. Micr. Club*, No. 39.

Godlewski, Prof. Dr. E.—On the Knowledge of the Causes of the Changes of Form in Etiolated Plants. *Bot. Zeit.*, XXXVII., Nos. 6-11.

Kraus, C.—Contributions to the Knowledge of the Movements of Growing Foliage and Flower Leaves (*concluded*). *Flora*, LXII., Nos. 4 & 6.

Lundström, A. N.—Elias Fries (Memoir and Portrait). *Journ. Bot.*, VIII., No. 194.

Schnetzler, Prof. J. B.—Some Observations on the Colouring Matter of Chlorophyll. *Bull. Soc. Vaud. Sci. Nat.*, XV., No. 80.

Tangl, Prof. Dr. E.—The Protoplasm of the Pea. II. (4 plates.) *SB. K. Ak. Wiss. Wien.*, LXXVIII. (Sec. I.), Part 1.

Tomaschek, A.—On Internal Cells in the Large Cell (Antheridium-cell) of the Pollen of certain Conifers. II. (1 plate.) *SB. Ak. Wiss. Wien.*, LXXVIII. (Sec. I.), Part 1.

B. CRYPTOGAMIA.

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Lewis, T. R., M.B.—See Zoology A.

Marchand, Dr. Léon.—Cryptogamic Botanical Rambles. (1 plate.) *Journ. de Micr.* III., No. 3.

Schmidt, A.—Biographical Sketch of C. H. Funck. *Flora*, LXII., No. 7.

Stevenson, Rev. J.—Report on the Scientific Portion of the (Scottish) Cryptogamic Society's Exhibition on October 11th, 1878. *Scot. Nat.*, V., No. 33.

White, F. B., M.D., F.L.S.—Glen Tilt; its Fauna and Flora (*continued.*) The Cryptogamic Flora. *Scot. Nat.*, V., No. 34.

Algæ.

Cleve, Prof. Dr. P. T.—Diatomaceæ of the West Indian Archipelago (*concluded*). *Journ. de Micr.*, III., No. 3.

Deby, J.—Observations on an Article entitled "The Thallus of the Diatomaceæ," by Dr. M. Lanzi. *Brebissonia*, I., No. 8.

Kitton, F., and Smith, Prof. H. L.—*Hyalodiscus subtilis* and *H. Californicus*, by F. Kitton and reply of Prof. H. L. Smith. (Translated from 'Am. Journ. Micr.') *Brebissonia*, I., No. 8.

Munier-Chalmas.—See Wright, E. P.

Petit, P.—Diatoms collected on *Conomitrium capense* Mull. *Brebissonia*, I., No. 8.

Reports of the Commission on the Desmazières Prize, awarded to Dr. Bornet for his 'Études Phycologiques,' and on the Thore Prize awarded to Prof. Ardissone for his 'Floridee Italiche.' *Comptes Rendus*, LXXXVIII., No. 10.

Schnetzler, Prof. J. B.—Notice on the Colouring Matter of *Porphyridium cruentum* Naeg. *Bull. Soc. Vaud. Sci. Nat.*, XV., No. 80.

Smith, Prof. H. L.—Description of New Species of Diatomaceæ (*continued*). (Translated from 'Am. Quart. Micr. Journ.') *Journ. de Micr.*, III., No. 3.

Stahl, E.—On the Resting State of *Vaucheria geminata*. (1 plate.) *Bot. Zeit.*, XXXVII., No. 9.

Stodder, C.—Notes on the Diatomaceæ of Santa Monica (California). (Translated from 'Am. Journ. Micr.) *Journ. de Micr.*, III., No. 3.
Tieghem, P. Van.—On the 'Gum' of Sugar works (*Leuconostoc mesenteroides*). *Ann. Sci. Nat.* (*Bot.*), VII., No. 3.
Wright, E. P.—Fossil Calcareous Algæ. (Review of Papers by M. Munier-Chalmas.) *Nature*, XIX., No. 491.

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Crombie, Rev. J. M., F.L.S.—Correlation of the Lichens in Robert Brown's 'Chloris Melvilliana.' *Jour. Bot.*, VIII., No. 196.
Lindsay, W. Lauder, M.D., F.R.S.E., F.L.S.—Fossil Lichens. *Trans. & Proc. Bot. Soc. Edin.*, XII., Part 2.
Müller, Dr. J.—Lichenological Contributions (*contd.*). *Flora*, LXII., No. 11.
Stirton, J., M.D., F.L.S.—Description of New Scottish Lichens. *Scot. Nat.*, V., No. 33.

Fungi.

Berkeley, Rev. M. J.—Mycology. *Nature*, XIX. No. 492.
Cooke, M. C., M.A., LL.D.—Enumeration of *Polyporus*. *Trans. & Proc. Bot. Soc. Edin.*, XIII., Part 2.
Crespigny, Dr. De.—Another Fungus Ramble in Epping Forest. (13 figs.) *Sci. Goss.*, No. 172.
Farlow, W.—On the Synonymy of some Species of Uredineæ. *Proc. Am. Ac. Arts & Sci.* (*Boston*), V.
Feltz, V.—Experimental Researches on a Leptothrix, found during life in the Blood of a woman attacked with severe Puerperal Fever. *Comptes Rendus*, LXXXVIII., No. 11.
Fries, E.—Icones Selectæ Hymenomycetum nondum delineatorum, Vol. II., Parts 2 and 3. (Plates 111–130.) (Fol. Stockholm, 1878.)
Gillet, C. C.—The Fungi of France. The Discomycetes, Part 1 (6 plates). (8vo. Alençon, 1878.)
Howse, T., F.L.S.—The Cryptogamic Flora of Kent—*Fungi*. *Journ. Bot.*, VIII., No. 195.
Keith, Rev. J., A.M.—Supplementary List of Fungi found within the Province of Moray (*concluded*). *Scot. Nat.*, V., Nos. 33 & 34.
Saccardo, P. A.—Fungi Italici autographice delineati. Parts 9–12. (4to. Padua, 1878.)
" " Mycotheca veneta sistens fungos venetos exsiccatos, Cent. XIV. (Padua, 1879.)
Sadler, J.—Notice of a New Species of Agaric (*Agaricus* (*Clitocybe*) *Sadleri*, Berkeley) (1 plate). *Trans. & Proc. Bot. Soc. Edin.*, XIII., No. 2.
Schulzer, S.—Mycological Notes. *Flora*, LXII., No. 9.
Schützenberger, P., and A. Destrem.—On Alcoholic Fermentation. *Comptes Rendus*, LXXXVIII., No. 11.
Stirling, A. B.—Notes on the Fungus Disease affecting Salmon (1 fig.). *Proc. Roy. Soc. Edin.*, IX., No. 100.
Thümen, F. Von.—Diagnoses to Thümen's 'Mycotheca universalis,' Cent. X.–XII. *Flora*, LXII., Nos. 4 & 7.

Characeæ.

Bennett, A. W., M.A., B.Sc., F.L.S.—A few last words on *Chara*. *Journ. Bot.*, VIII., No. 195.

Muscineæ.

Bagnall, J. E.—Moss Habitats (*continued*). *Mid. Nat.*, II., No. 16.
Brin and Camus.—Bryological Notice on the Environs of Cholet (*continued*). *Rev. Bry.*, VI., Nos. 1 & 2.
Fergusson, J.—Notes on some British Mosses. " "
Geheeb, A.—On the New Mosses discovered by M. Breidler in the Styrian and Lungovian Alps in 1878. *Rev. Bry.*, VI., Nos. 1 & 2.
" Notes on some rare or little-known Mosses. " "
Jaeger, Dr. A., and Fr. Sauerbeck—Conspectus Systematis Generum Muscorum et Summa Specierum. *Rev. Bry.*, VI., Nos. 1 & 2.
List of European Bryologists. 4th Supplement. " "

Renauld, F.—Notice on some Mosses of the Pyrenees (*continued*).
Rev. Bry., VI., Nos. 1 & 2.

Venturi.—Study of *Orthotrichum Schubartzianum*, *O. Venturii*, and *O. urnigerum.* *Rev. Bry.*, VI., Nos. 1 & 2.

Vascular Cryptogams.

Baker, J. G., F.R.S., F.L.S.—Report on a Collection of Ferns made in the North of Borneo by Mr. F. W. Burbidge. *Journ. Bot.*, VIII., No. 194.

„ „ Report on Burbidge's Ferns of the Sulu Archipelago.
Journ. Bot., VIII. No. 195.

Ross, George.—On the Flora of Mull.
Trans. & Proc. Bot. Soc. Edin., XIII., No. 2.

MICROSCOPY, &c.

Adan, H. Ph.—The Invisible World revealed, Parts 9–16 (*conclusion*). (8 plates.) (8vo. Brussels and Paris, 1879.)

Dippel, Dr. L.—The Objectives for Homogeneous Immersion of Carl Zeiss
Flora, LXII., No 11.

Examination of Powders: a new Employment for the Microscope (from 'Young Scientist'). *Am. Journ. Micr.*, IV., No. 2.

Marsh, Dr. S.—Knives for cutting Sections (from 'Section Cutting'). (3 figs.)
Am. Journ. Micr., IV., No. 2.

Morehouse, G. W.—On Searching for Trichinæ. *Am. Journ. Micr.*, IV., No. 2.

Newton, E. T., F.G.S.—On a new Method of preparing a Dissected Model of an Insect's brain from Microscopic Sections. (5 woodcuts.)
Journ. Quek. Micr. Club., No. 39.

Pelletan, Dr.—On Microscopic Preparations. *Journ. de Micr.*, III., No. 3.

„ „ Self-centering Whirling Table of W. Bulloch. (1 fig.)
Journ. de Micr., III., No. 3.

Petit, P.—Preparation of Diatoms in situ. Means of Avoiding Air-bubbles.
Brebissonia, I., No. 8.

Quincke, Prof.—Extracts from two Letters on the Refractive Indexes of Glass and Quartz, as tested by reflection from the surface.
Proc. Roy. Soc. Edin., IX., No. 100.

Rolleston, Prof., F.R.S.—Note on the Preservation of Encephala by the Zinc Chloride. *Journ. Anat. & Phys.*, XIII., Part. 2.

Schulze, A.—An Easy and Simple Method of Resolving the finest-lined Balsamed Diatomaceous tests by transmitted Lamp-light, &c. (from this Journal).
Am. Journ. Micr., IV., No. 2.

Universal Sub-Stage for Oblique Light. *Am. Journ. Micr.*, IV., No. 2.

Vanden Broeck, E.—Medley of Microscopy. Notices, &c., presented to the Belgian Society of Microscopy. (8vo. Brussels, 1879.)

Wilkins, T. S.—Microscopic Pond Life (*continued*).
Am. Journ. Micr., IV., No. 2.

PROCEEDINGS OF THE SOCIETY.

MEETINGS OF 9TH APRIL, 1879, AT KING'S COLLEGE, STRAND, W.C.
DR. BEALE, F.R.S., PRESIDENT, IN THE CHAIR.

The Minutes of the meeting of 12th March last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Ardissone, F.—Le Floridee Italiche descritte ed illustrate. Vol. i. fasc. v., 2 plates, 8vo. Milan, 1874	*The Author.*
—— La Vie des Cellules et l'Individualité dans le Règne Végétal. Traduit par A. Champseix. 8vo. Milan, 1874	*Ditto.*
Carus, J. Victor, and W. Engelmann.—Bibliotheca Zoologica. 2 vols. 8vo. Leipzig, 1861	*Dr. Beale.*
Gegenbaur, C.—Grundzüge der Vergleichenden Anatomie. (319 woodcuts.) 2te Aufl. 8vo. Leipzig, 1870	*Ditto.*
Home, Sir Everard, Bart.—Lectures on Comparative Anatomy. (171 plates.) Vols. iii. and iv. 4to. London, 1823 ..	*Mr. Crisp.*
Orth, Dr. J.—A Compend of Diagnosis in Pathological Anatomy. Translated by Dr. F. C. Shattuck and Dr. G. K. Sabine. Revised by Dr. R. H. Fitz. (2 plates). 8vo. Boston, 1879	*Ditto.*
Pelletan, Dr. J.—Le Microscope: son Emploi et ses Applications. (4 plates and 278 woodcuts.) 8vo. Paris, 1876 ..	*Dr. Beale.*
Roper, F. C. S.—Flora of Eastbourne. 8vo. London, 1875 ..	*The Author.*
Siebold, C. Th. v., and H. Stannius.—Comparative Anatomy. Translated from the German and edited by Dr. W. J. Burnet. Vol. i. Anatomy of the Invertebrata. 8vo. London and Boston, 1854	*Dr. Beale.*

The Books which the Council had decided to purchase out of the Quekett Fund, in pursuance of their last Report, were stated to be the following:—

Encyclopædia Britannica. 9th ed. Vols i.-ix. 4to. Edinburgh, 1875–9.
Botanischer Jahresbericht. Vols. i.-iv. 8vo. Berlin, 1874–8.
Zoological Record. Vols. i.-xiii. 8vo. London, 1875–78.
Ehrenberg, C. G.—Mikrogeologie, and Continuation. Fol. Leipzig, 1854–6.
Gegenbaur, C.—Elements of Comparative Anatomy. (Translated by Bell and Lankester.) 8vo. London, 1878.
Haeckel, E.—Die Radiolarien. Fol. Berlin, 1862.
Hertwig, R.—Der Organismus der Radiolarien. 4to. Jena, 1879.
Huxley, T. H.—Manual of the Anatomy of Vertebrated Animals. 8vo. London, 1871.
—— Manual of the Anatomy of Invertebrated Animals. 8vo. London, 1877.
Nicholson, H. A.—Manual of Zoology. 5th ed. 8vo. Edinburgh and London, 1878.
—— Manual of Palæontology. 8vo. Edinburgh and London, 1872.
Ranvier, L.—Traité technique d'Histologie. Fasc. 1-5. 8vo. Paris, 1875–8.
Stein, F. Ritter von.—Der Organismus der Infusionsthiere. Parts I. II. and III. (1st Half). Fol. Leipzig, 1859–78.
Thuret, G., and E. Bornet.—Études Phycologiques. Fol. Paris, 1878.

The books were laid upon the table.

Mr. Stewart called attention to two slides exhibited by Mr. Dreyfus, one of which (*Poteriodendron petiolatum*) was one of the remarkable flagellate Infusoria (figured in Stein's work), in the form of a tree goblets of glass-like transparency, an outline of which he drew on the board. It had been found in one of the ponds at the Zoological Gardens. The other slide was a fungus (*Gymnosporangium*), one of the *Uredineæ*.

Mr. Crisp called attention to the fact of Messrs. Powell and Lealand having constructed a $\frac{1}{8}$ oil-immersion objective, which they had brought for exhibition.

Professor Keith's "Note on Diagrams exhibiting the path of a ray through Tolles' $\frac{1}{8}$ Immersion Objective" was read by Mr. Crisp (see p. 269 and Plate XII.) and the diagrams exhibited. The original diagram copied on p. 143 of vol. i. and computation forming Plate VII. of that volume were also shown.

Mr. Wenham's "Reply to Professor Keith's Note" (see p. 270) was read (see p. 271).

Mr. Crisp stated that the Council had come to the conclusion that it was desirable to close the controversy on the aperture question, and that, with the possible exception of a paper promised by Professor Abbe, it was not intended to print any further communications on the subject beyond those read this evening.

Mr. Tolles' paper on "An Illuminating Traverse-Lens" was read by Mr. Crisp, and the apparatus exhibited and illustrated on the blackboard.

Dr. Edmunds said that homogeneous immersion was nothing less than a new point of departure for high-power objectives—such lenses going as far beyond water lenses as these go beyond air lenses. The enormous resolving power of homogeneous immersion lenses could only be brought out by corresponding illumination. For such illumination the immersion principle was indispensable. He had long worked with immersion illuminators, and found them perfectly easy to manage. A crown lens, half an inch in radius and in depth an entire hemisphere minus the thickness of the slide, would, when connected to the slide with oil, do almost everything in the way of oblique illumination, and no Microscope was now complete without such an accessory. The travelling plano-concave addendum of Mr. Tolles, though very pretty in theory, was not, he thought, of much use as a working tool.

Dr. Hudson's "Note on Mr. Deby's paper" (as to the identity of *Pedalion* Hudson and *Hexarthra* Schmarda—see p. 111) was read by Mr. Crisp, and the two comparative drawings made by Dr. Hudson enlarged on the board by Mr. Stewart.

Mr. Crisp said that at the last meeting mention was made (see p. 220) of some experiments which Professor Abbe was conducting with the view of finding some immersion fluid that could be substituted for oil, and chloride of zinc was referred to as a possible fluid. After the meeting, however, some of the Fellows expressed the opinion that chloride of zinc would dissolve the brass setting of the objectives, in consequence of which Mr. Stephenson had communicated with Professor Abbe on the subject, and in reply he said that "what he spoke of was not the ordinary chloride of zinc, obtained by dissolving zinc in hydrochloric acid, but the chloride released from water (anhydric) by distilling it over. The ordinary zinc salt would not give sufficient refraction."

Mr. Zeiss had also sent over four samples of the following solutions (which were shown to the Meeting), viz.:—

(1) Chloride of cadmium in glycerine ($CdCl_2$), 1·504.
(2) Copaiva balsam oil, 1·504.
(3) Chloride of zinc in water ($ZnCl_2$), 1·504.
(4) Sulpho-carbolate of zinc in glycerine, 1·501.

The chloride of cadmium in glycerine Professor Abbe describes as somewhat too thick for convenient use, but very good in optical respects. It is literally "fluid crown glass, its dispersion being almost equal to that of ordinary crown. The oil of copaiva balsam he pronounces to be "in every respect perfectly equal to oil of cedar-wood, but not quite so fluid."

Mr. Stephenson said that just before he came to the meeting he had received a letter from Professor Abbe (7th April), in which he further said, "As to the chloride of zinc, we have tried it repeatedly, and have found no obstacle, but it does not allow a *prolonged* immersion with the same drop. After ten to fifteen minutes' exposure, it deposits small crystals, as it seems, on the slide and on the front lens, whereby the optical effect is considerably deteriorated, though all can be cleaned off by water and alcohol. In using this solution, therefore, the slide and objective should be cleaned after ten minutes' observation, and a fresh drop taken. If the objective is well cleaned at the end of the observation, wiping it finally with alcohol, there will be no damage at all. With the glycerine, good cleaning of the preparations and of the objective is also necessary, as glycerine has a very strong adhesion to glass."

Mr. Ingpen inquired if there would be any difficulty in making the ends of the fronts of the objectives of platinum?

Dr. Edmunds said that he had written to Herr Zeiss suggesting that the front lens should be set in platinum, because of its incorrodibility, and because, under variations of temperature, its coefficient of expansion was almost identical with that of crown glass. Herr Zeiss, while admitting these advantages in platinum, pointed out that its want of rigidity was fatal, inasmuch as for the fronts of these high-angled lenses, the setting had to be turned out very hollow, and to an edge little thicker than a sheet of writing paper. Such a setting if in platinum would collapse under slight pressure, and the lens

would be spoilt. Therefore Herr Zeiss used a very hard nickel alloy.

As to aqueous fluids, great caution was needed, as some of them might corrode the metal setting, and unship the front lens; some, such as zinc chloride, would be very hygroscopic, and, after a few minutes in a dry or moist atmosphere, would vary so rapidly in refractive index as to be useless for such a purpose; others would penetrate by capillary attraction past the edge of the lens, and gum up the margin of the back surface, so as to reduce the working angle of the lens and introduce diffraction phenomena. Therefore an oily fluid would probably after all prove the best. Shellac was proof against cedar oil, and would answer perfectly for mounting objects, and perhaps also for consolidating the front lens in its narrow setting, so as to prevent capillary action at its margin.

A letter was read from Mr. Adolf Schultze, of Glasgow, well known as an expert manipulator, in which he said that "though he had not had time to examine these fluids closely, yet he was able to say that by their use with the $\frac{1}{18}$ he at once resolved *A. pellucida* and other fine diatomaceous tests as distinctly as with cedar-wood oil. The cadmium chloride in glycerine and sulpho-carbolate of zinc in glycerine being very thick and sticky, might, he thought, suit the $\frac{1}{8}$ well, as it has a very large working distance. Copaiva balsam oil he thought on the whole the best substitute for cedar-wood oil. Although these liquids do not act as solvents on the Canada balsam and the varnish rings of objects, and (with the exception of the copaiva) are free from smell, yet he doubts whether their use offers any important advantages over cedar-wood and fennel oil, whose smell is not offensive if employed in very small quantities. Three of the four fluids require to be washed off from the slide and the front lens with water, whilst for copaiva and the other oils a little blotting paper suffices."

With regard to the $\frac{1}{18}$ oil-immersion, Mr. Schultze also said:— "It is my opinion that this lens is at present perhaps the finest immersion objective of the same focus made, and that it is not likely soon to be surpassed. My specimen (No. 3) has a magnifying power of 980 diameters, with Ross's A eye-piece, and a working distance of about 0·004 inch, its definition is very fine, and its resolving power is as remarkably great as that of the $\frac{1}{8}$ and the $\frac{1}{12}$ of the same series. Its field is quite flat, as far as I can see on the tests at my command, and it gives a great deal of light, so much so that when using a microscopic lamp with a wick half an inch broad, the markings of *A. pellucida* are still visible under Ross's F eye-piece, or under a power of 8000 diameters. Apart from magnification and working distance there seems little to choose regarding other optical qualities between Zeiss's three objectives of $\frac{1}{8}$, $\frac{1}{12}$, and $\frac{1}{18}$ inch focus on the homogeneous immersion system."

Mr. Stephenson, in reading his paper on "The Vertical Illuminator and Oil-Immersion Objectives" (see p. 266), said that it was now found that the kind of illumination furnished by the vertical illuminator

was exceedingly valuable in the case of large-angled objectives. He had no valve of *Amphipleura pellucida* which he had not been able to resolve although he had been often told by opticians that some of his slides were of no value, being quite "washed out"; as for *Surirella gemma*, the whole valve was seen to be covered with knobs. Mr. Morehouse, in the extract quoted in the last number of the Journal (p. 194), pointed out that the vertical illuminator would only work well with large aperture lenses, and it would be found that it was only with very large angles, exceeding 180°, that it acted effectively.

Mr. Curties asked what Mr. Stephenson considered the best form of illuminator.

Dr. Edmunds said he would be glad to know whether Mr. Stephenson had compared the reflecting prism, the disk of thin glass, and the opaque steel mirror as practical tools? Would it be best to work the illuminator from the side of the Microscope tube, or in the optic axis, and at what point behind the objective would the reflector work best on the object, and do the least damage to the image received by the eye-piece?

Mr. Stephenson said that the apparatus he had used was the one with a parallel plate of glass. In one respect a small prism was no doubt better, because with the plate of glass light was received from both surfaces, which tended to confuse the image. The prism was certainly better than the steel disk, and it was essential that it should be placed at the side of the tube. Of course just so far as the prism projected over the edge of the objective, the aperture of the glass would be diminished. Dr. Carpenter gave the preference to the thin glass disk over the fixed parallel plate, both on account of its superior reflecting power, and the ease with which it could be set at any inclination.

Mr. Crisp said that Mr. Stephenson's demonstration of the excess of aperture over 180° was the most interesting that had yet been suggested on that subject. With regard to slides of *Amphipleura* being washed out, he had been frequently assured when objectives were being tried on his own slides, that the slides were "not those of the *Amphipleura* which had markings, but a variety which had no markings." It should be mentioned that Mr. Adolf Schulze had early last year discovered the power of the vertical illuminator, when used with oil-immersion objectives, to resolve *Amphipleura*. He unfortunately delayed the publication of the method through an accident.

The President being obliged to leave, the chair was taken by Dr. Braithwaite, V.P.

Mr. Crisp brought forward the resolution of which he gave notice at the last meeting, as to a standard unit of micrometry. He said that he had little to add to what he then stated. His motive in bringing the resolution forward was, 1st, that they as the oldest Microscopical Society in existence, should express an opinion one way or the other on a subject which was considerably agitating their fellow workers in America, and 2nd, his conviction that it would be a grievous error for

any body of microscopists to adopt the $\frac{1}{100}$ of a millimetre for the standard as had been recommended.

Dr. Edmunds in seconding the resolution said that the $\frac{1}{100}$ of a millimetre was clearly too large, while the $\frac{1}{1000}$ being less than one-seventh the diameter of a human blood-corpuscle, showed that it was sufficiently small for all the work of practical histology.

Mr. Stephenson said that he entirely agreed with the views which Mr. Crisp had expressed as to the $\frac{1}{100}$ of a millimetre, which was obviously much too high a standard, leading as it constantly would to the use of fractions of the unit which it ought to be one of the essential qualities of a standard to avoid. At the same time he considered that the time had not arrived when they ought to formulate in a resolution a positive injunction as to the use of any given standard. So far as that was desirable, it had already been done by the Leyden resolution of Professor Suringar He would therefore move—

> "That in the opinion of this Society, the $\frac{1}{100}$ of a millimetre is too large a unit for micrometric measurements, and that it is not expedient at present to prescribe by any formal resolution the adoption of a fixed standard for micrometry."

Mr. Michael thought that if they were to have a standard at all the one proposed was perhaps the best to be adopted. But the question in his mind was, whether it was desirable or convenient to establish a special standard for the purpose of microscopy alone? The greater part of the work requiring measurements was done by those who engaged in it as a part of their ordinary work, and in such case it would be difficult to say what was microscopic work to which this new standard was to apply in place of the ordinary methods of measurement. He thought therefore that the adoption of a new standard required very grave consideration.

Mr. Curties was certainly not in favour of attempting to come to any decision now as to the adoption of a standard.

The Chairman, having put the amendment to the Meeting, declared it to be carried.

A letter from Professor R. Hitchcock, of New York (of 12th March), as to standard micrometers, was read by Mr. Crisp, of which the following is an extract:—"As to standard micrometers, I cannot understand why there is so much opposition to adopting a standard division. I believe that such a divison will be adopted here, and that the metric system will supersede all others. It requires only a slight familiarity with micrometers ruled on this system to convince anyone of their superiority. As to the question of accuracy, I assume, and with propriety, that divisions of $\frac{1}{100}$ mm., or $\frac{1}{1000}$ inch, can be ruled so that the variations from a given standard are measured by *millionths of an inch*, varying from ± 0 to ± 25 millionths at a given temperature. I have a "standard cm." in which the average variation in the spacing is not far from 10 millionths of a mm., according to the determinations of Professor Rogers, the maker. (I speak from memory; it may be a little more than this, but some of the

variations are only 3 millionths.) The only question remaining is, is the standard from which the work is done true? Well, I believe it will be shown that it is; but suppose not, is it not infinitely better to have a standard measure, even though it be not an *absolutely accurate* subdivision of a metre or inch, so long as it is possible to make all standards agree, than to have so much confusion as we find at present? I hope your Society will take this view of it, and I am sure that any man who has ever undertaken to prepare a standard micrometer for his own use from a comparison of those in the market, will need no argument to convince him of the value of this undertaking. Why should we go on, year after year, publishing microscopic dimensions from micrometers which we know are not true? All such work will need revision in the future, if it is of any value at least.

I did not mean to say all this. However, I do hope your Society will have something to say about this matter, and co-operate heartily with what may be done here. The matter is in good hands on this side of the water, and what action is taken will be final I believe. Above all things, let us try to avoid the adoption of one standard here and another in England."

Mr. Crouch said that, having had the pleasure of seeing Professor Rogers and his machine, he thought it was not at all likely that anyone on this side of the Atlantic would be disposed to go to the expense that had been gone to in the matter by that gentleman.

The Chairman announced that the second Scientific Evening of the Session would be held on the 21st May, in the Library of King's College.

A SPECIAL GENERAL MEETING was then held pursuant to notice.

Dr. Braithwaite moved, and **Mr. Stewart** seconded, the following resolution:—

> That Bye-law 7 be amended by substituting "31*l.* 10*s.*" for "21*l.*"

He said that it had been pretty generally found by the scientific Societies that the Composition Fee was too low; the Linnean Society had recently raised it from 30*l.* to 45*l.*, and the Council now recommended a proportionate increase. It would, of course, apply only to Fellows nominated after this date.

Dr. Edmunds considered that it was not desirable that the Composition Fee should be increased.

The resolution was put to the Meeting and carried, with three dissentients.

Mr. Crisp moved, and **Dr. Matthews** seconded, the following resolution:—

> That Bye-law 15 *b* (see p. 212) be amended by inserting the following words at the end of the first paragraph thereof—"or of the Presidents or Chairmen of the Biological or Microscopical sections of such Societies."

It had been found that some of the Societies nominated under the

Bye-law had separate Biological or Microscopical sections, and it was considered to be more appropriate that in such cases the President or Chairmen of those sections should be Ex-officio Fellows rather than the Presidents of the Societies. In the Royal Societies of the Australian colonies, for instance, the Governor of the colony was generally the President.

The resolution was carried unanimously.

The following objects and apparatus were exhibited:—

Mr. Dreyfus:—(1) *Poteriodendron petiolatum* (Flagellate Infusoria). (2) *Gymnosporangium* (Fungus).

Messrs. Powell and Lealand:—$\frac{1}{8}$ oil-immersion objective of their own manufacture, shown with *P. angulatum*.

Mr. Stephenson:—Vertical illuminator, with Zeiss' oil-immersion $\frac{1}{18}$ objective, shown with *Surirella gemma* and *Amphipleura pellucida*.

Mr. Ward:—Section of stem of *Hodgsonia heteroclita* (Himalayahs).

Mr. Crisp:—(1) Dr. H. Hager's Compressor-Microscope for Trichinæ, &c., combining a Compressorium and a Microscope (Hager, 'Das Mikroskop,' 6th ed., Berlin, 1879, p. 41). (2) Beck's achromatic condenser (see p. 328). (3) Two slides of compound vibration curves by Mr. Washington Teesdale. (4) Professor Keith's original computation and diagram, vol. i. plate vii. and p. 143, and the further drawing described in his last paper, vol. ii. p. 269 and plate xii.

New Fellows.—The following were elected *Fellows*, viz.:—Captain Cyril Frampton, R.M.; Dr. W. M. Ord, M.D., F.R.C.P.; and Messrs. F. M. Campbell, G. Chandler, G. D. Plomer, G. W. Ruffle and J. J. Vezey.

Honorary Fellows.—Rev. M. J. Berkeley (Sibbertoft, Market Harborough); G. R. Waterhouse (London); W. Archer (Dublin); L. Pasteur and L. Ranvier (Paris); P. J. Van Beneden (Louvain); A. de Bary (Strassburg); F. Cohn (Breslau); A. v. Kölliker (Würzburg); C. Nägeli (Munich); S. Schwendener (Berlin); A. Grunow (Berndorf, near Vienna); F. Ritter von Stein (Prague); M. J. Schleiden (Dorpat); J. Leidy (Philadelphia).

Societies whose Presidents for the time being are Ex-officio Fellows under Bye-Law 15b.

UNITED KINGDOM.

London and Suburbs.

Quekett Microscopical Club
South London Microscopical and Natural History Club
Croydon Microscopical and Natural History Club

Provinces.

Birmingham Natural History and Microscopical Society
Brighton and Sussex Natural History Society
Bristol Microscopical Society
Bristol Naturalists' Society
(Canterbury.) East Kent Natural History Society
Cardiff Naturalists' Society
Eastbourne Natural History Society
Leeds Philosophical and Literary Society
Liverpool, Literary and Philosophical Society of
Liverpool, Microscopical Society of
Manchester, Literary and Philosophical Society of
(Norwich.) Norfolk and Norwich Naturalists' Society

(Newcastle-upon-Tyne.) North of England Microscopical Society
(„) Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne
Plymouth Institution and Devon and Cornwall Natural History Society

Scotland.

Glasgow, Natural History Society of
(Perth.) Cryptogamic Society of Scotland
(„) Perthshire Society of Natural Science

Ireland.

Dublin Microscopical Club
Belfast, Natural History and Philosophical Society of

COLONIES.

India.

(Calcutta.) Asiatic Society of Bengal

Australasia.

New South Wales, Linneau Society of
New South Wales, Royal Society of
Tasmania, Royal Society of
Victoria, Royal Society of
(New Zealand.) Wellington Philosophical Society

Canada.

(Halifax.) Nova Scotian Institute of Natural Science
Montreal, Natural History Society of
(Toronto.) Canadian Institute

UNITED STATES.

(Boston.) American Academy of Arts and Sciences
Boston Society of Natural History
(Chicago.) State Microscopical Society of Illinois
New York Academy of Sciences
New York Microscopical Society
Philadelphia, Academy of Natural Sciences of
San Francisco Microscopical Society
Troy Scientific Association

GERMANY.

Berlin, Gesellschaft Naturforschender Freunde zu
(Dresden.) Naturwissenschaftliche Gesellschaft "Isis"
(Frankfurt a M.) Senckenbergische Naturforschende Gesellschaft
Göttingen, K. Gesellschaft der Wissenschaften zu
Jenaische Gesellschaft für Medecin & Naturwissenschaft
(Leipzig.) K. Sächsische Gesellschaft der Wissenschaften

AUSTRIA-HUNGARY.

Wien, K.K. Zoologisch-botanische Gesellschaft in

HOLLAND.

Haarlem, Hollandsche Maatschappij der Wetenchappen te (Société Hollandaise des Sciences à Harlem)

SWITZERLAND.

Basel, Naturforschende Gesellschaft in
Bern, Naturforschende Gesellschaft in
Genève, Société de Physique et d'Histoire Naturelle de
(Lausanne.) Société Vaudoise des Sciences Naturelles
Zürich, Naturforschende Gesellschaft in

FRANCE.

(Amiens.) Société Linnéenne du Nord de la France
Lyon, Société Linnéenne de
Montpellier, Académie des Sciences et Lettres de
(Paris.) Société Botanique de France
(„) Société Cryptogamique de France

BELGIUM.

(Brussels.) Société Belge de Microscopie
(„) Société Royale de Botanique de Belgique

ITALY.

Milano, Istituto Lombardo di Scienze e Lettere di
(„) Società Crittogamologica Italiana
(Pisa.) Società Toscana di Scienze Naturali
Torino, R. Accademia delle Scienze di
(Venezia.) R. Istituto Veneto di Scienze, Lettere, ed Arti

SPAIN.

(Madrid.) Sociedad Española de Historia Natural

RUSSIA.

Moscou, Société Impériale des Naturalistes de
(Odessa.) Société des Naturalistes de la Nouvelle Russie

᛫ JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE, 1879.

TRANSACTIONS OF THE SOCIETY.

XIX.—*On the Development and Retrogression of the Fat-cell.*

By George Hoggan, M.B., and Frances Elizabeth Hoggan, M.D.

(*Read* 12*th March*, 1879.)

Plates XIII. and XIV.

Part I.—*Development of the Fat cell.*

If in the animal body there be one element whose simple structure and generally accessible position would lead us to expect that its life-history could easily be traced, and that consequently a general unanimity of opinion regarding it must necessarily exist

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DESCRIPTION OF THE PLATES.

Plate XIII.—Development of Fat-cells.

Fig. 1.—First deposition of fat in wandering cells retracted into a globular form, from broad ligament of pregnant mouse. *a*. First appearance of fat in a cell as two minute oil-globules. *b*, *c*, *d*, *e*, *f*. Cells in which gradual increase of contained fat can be traced towards the capillary. *g*. Cells similar to *a* in which no fat has as yet been deposited. All the above cells lie beneath the endothelium and in the matrix of the membrane. *h*. A wandering cell with constricted nucleus lying in one of the holes in the membrane, and therefore on the free surface; it is evidently only a younger form of *g* and *h*. *i*, *j*. Still younger specimens of wandering cells lying on the free surface of the membrane; *i* has two nuclei. *k*. Nuclei of the endothelium covering both surfaces of the membrane.

Fig. 2.—Relation of fat-tracts to wandering cells, from mesentery of rat. *d*, *e*. Members of a shoal of wandering cells lying on free surface of endothelium. *a*. A member of the same kind of cells, but lying beneath the surface of the endothelium. *b*, *c*. Cells similar to the above, but further advanced, lying also underneath the endothelium and becoming fat-cells; *b* has already two fat-globules within it, and has attached itself to the group of fat-cells of which *f* is a fully developed specimen. Only the cell-markings of the upper surface endothelium are drawn, except at *a*, where the dotted line marks the lower surface cell-markings.

Fig. 3.—First deposition of fat in wandering cells fixed in their branched condition, from the broad ligament of a pregnant mouse. All these cells lie in the matrix of the membrane. Nuclei of endothelium not inserted.

Fig. 4.—Fat-cells developing centrally as regards the blood-vessel, from the broad ligament of a pregnant rat. *g*, *g*. Fat beginning to be deposited in cells close to the blood-vessel. *a*, *a*. Cells fully distended with fat, lying farther away from blood-vessel; in these cells the fat has been slowly and steadily accumulating. *b*, *b*. Cells containing many fat-globules, the result of rapid deposition.

Fig. 5.—From the mesentery of a rat found starving, to which plenty of rich

amongst observers, we might certainly suppose that the fat-cell was that element.

Instead of this unanimity, however, we find the most opposite opinions held at the present day as to its origin alone, while about its disappearance, so far as we can discover, nothing really definite is known. We therefore propose in this paper to trace the life-history of the fat-cell from its origin in the wandering cell, its development, its decline, and its final disappearance from the stage under the same form in which it made its first appearance there.

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food was given, and the animal killed twenty hours afterwards. Tissue treated with silver, osmic acid, and logwood solutions. *b, c, d.* Cells in which many globules of fat have been deposited rapidly. These cells were probably previously fat-cells from which the fat had been absorbed, as seen in Figs. 9 and 10. *f, g.* Cells from which fat had not only been absorbed, but whose protoplasm had been disintegrating by granular exodus, as seen in Figs. 10, 12, and 13. The return of nutriment sent the granules back to the cell, where they now stain so intensely as in most cases to hide the nucleus. In *g* the nucleus is visible, and although stained as deeply as the nuclei of the neighbouring cells, it appears almost colourless as compared with the intense blue of the clustering granules round it. *a.* Vein. *h, h.* Nuclei of the endothelium.

Fig. 6.—Margin of a group of fully developed fat-cells, as they are generally seen, from the mesentery of a guinea-pig, treated with silver and logwood solutions and mounted in varnish, showing the effect of compression in making them assume a polyhedral shape. *a, a.* Fat-cells whose free borders still retain the circular form. *b, b.* Fat-cells assuming the polyhedral form through pressure of neighbouring fat-cells. This is the form in which they are found in nine cases out of ten.

Fig. 7.—Fat becoming absorbed from fat-cells. From the omentum of a young man who died of cancer and much emaciated. More than one-half of the contained fat has been absorbed from the cells.

Fig. 8.—Fat-absorption in a further advanced stage than Fig. 7, from the subcutaneous tissue of a young man who died of Eastern leprosy, much emaciated. Tissue treated with osmic acid and picro-carmine. Some of these cells still retain the angular form they possessed when fully distended with fat and compressed by neighbouring fat-cells.

Plate XIV.

Fig. 9.—Still further advanced stage of fat-absorption, from the broad ligament of a pregnant mouse, found almost dead from starvation. In this specimen the first stage of retrogression—that of fat-absorption—is seen completed. *a, a.* Monoglobular fat-cells, once fully distended, by fat now undergoing absorption. *b, b.* Multiglobular fat-cells undergoing fat-absorption in the multiglobular condition. *c, c.* Fat-cells from which all the fat has been absorbed. *d, d.* Nuclei of the surface endothelium. *e, e.* Edge of dense tract of exhausted fat-cells lying along lines of great blood-vessels. *f.* Capillary blood-vessel. No difference is traceable between the fat-cells in man and those of the smaller mammals.

Fig. 10.—From the same preparation as Fig. 9, showing the commencement of the second stage in retrogression of the fat-cell, when the cell-substance breaks up and moves off in the form of granules. *h.* Group of exhausted fat-cells from which all the fat has become absorbed. *a.* General break up of one of the cells of the group; the granules are seen passing away from it in every possible direction. *b, c.* Similar cells, in which the break-up is even further advanced. *f.* Spindle-shaped cell belonging to a capillary now broken up. *k.* Nuclei of surface endothelium.

Fig. 11.—From the same animal as Fig. 5, where fat has been deposited in cells similar to those seen in group *h*, Fig. 10. These cells had undergone granular change but not exodus, so that the newly formed fat-globules appear

This task proves much simpler than might have been expected, considering the opposite opinions held on the subject, partly owing to the modifications we have introduced into methods of preparation of tissues for examination, and partly because we find that the opposite opinions referred to are due principally to the fact that observers have regarded the same cell element from different points of view, in different shapes, and under different aliases; so that, while those who have examined it from the front have insisted that the fat was first developed in a flat or round cell, those who have

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imbedded in a granular matrix, unlike that in Fig. 5, which is transparent and had not retrograded so far as in this figure. *a, a.* Exhausted and granular fat-cells in which fat has been re-deposited. *b.* Similar cell, from which some of the fat has been extruded, but its protoplasm, having been previously fixed by silver and osmic acid, has not contracted. *c.* Granular cells which had undergone exodus, but to which the granules have returned. *d.* Wandering cell. Preparation stained with logwood.

FIG. 12.—Preparation from a rat which died of old age, showing a mass of fat-cells undergoing granular exodus and moving off *en masse* from the bed where they had been formed. *a.* Wandering cell. *b.* Exhausted fat-cells which have not undergone granular exodus. *c, c.* Fat-cells undergoing granular exodus and moving off *en masse.* Preparation treated with silver, osmic acid, and picro-carmine.

FIG. 13.—From the same preparation as Figs. 9 and 10; shows the end of the second stage of retrogression of the fat-cell. *a, a.* Fat-cells in a further advanced stage of exodus than those in Figs. 10 and 12. *b.* Cell in the last stage of granular exodus, nucleus and cell-outline again becoming distinct. *d, d.* Group of cells in a branched condition, and still containing a few granules. They appear to be the wandering cells, resulting from original fat-cells, lying in the same position as the group *e.* *f.* Spindle-shaped cells, resulting from the break-up of capillaries that were distributed to the now absorbed fat-tract. *g.* Large blood-vessel, now contracted and about to break up into spindle-cells. *h.* Nuclei of surface endothelium.

FIG. 14.—From the same animal as Fig. 12; shows different stages in retrogression of fat-cells, where the granules have returned, consequently upon some short return of nutrition. *e, e.* Cells in a fat-tract which have not yet undergone granular break-up. *c, c.* Cells undergoing granular exodus. *b, b.* Cells which have undergone granular exodus, but to which the granules have returned. *a.* A cell midway in condition between *b* and *c*, and which is assuming the branched or wandering condition. *f.* Nuclei of surface endothelium. *d.* Capillary of fat-tract. Preparation treated with silver, osmic acid, and logwood.

FIG. 15.—From mesentery of young rat weaned naturally by its mother about a week previously, consequently upon which, although well supplied with food, it had become very lean, and showed granular cells in the branched or wandering condition. *a, a.* Branched granular cells lying alongside a blood-vessel, to be compared with the ordinary branched cells, *b, b,* commonly called connective-tissue cells, but virtually wandering cells.

FIG. 16.—From the same animal as Fig. 15, showing granular cells *a, a,* lying amidst a group of ordinary wandering cells *b, b,* in a natural hole of the broad ligament of the liver, and, therefore, on its free surface, which they have probably reached as seen in Fig. 15. These cells are now in the condition of cell *h,* Fig. 1, with which we commenced, and in the same preparation different stages of the granular cells may be traced, until they end in the ordinary wandering cell.

All these drawings have been made by the camera lucida, under the same power of 800 diameters, reduced afterwards one-half except Figs. 9 and 11 reduced to one-third. When not otherwise stated, the tissues have been fixed by silver, stained by pyrogallate of iron, and mounted in glycerine.

seen it edgeways have as stoutly maintained that it was developed from a branched or spindle cell.

Thus it is that Flemming, whose researches, published nine years ago, are probably the most extensive on this subject, not only insists that fat-cells are developed from the branched fixed cells of the connective tissue alone, but he emphasizes this opinion by declaring that he commenced his investigations in the full belief that fat-cells were developed from wandering cells, and that his investigations forced him to give up this his original idea. Klein also, whose opinions on this question are probably the latest that have appeared in English, does not seem to have worked out the question for himself, but accepts and teaches Flemming's conclusions, with the exception of the one where Flemming holds that the fat-cells are developed from the adventitia of blood-vessels.

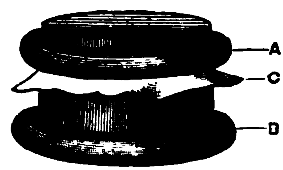
He also specially refers his readers to the branched cells of the fossa infraorbitalis of rabbits as the most suitable in which to study the development of fat-cells, and states "that he thinks it unnecessary to warn his readers against the possible assumption that the lymph-corpuscles are the elements which become converted into fat-cells."

Ranvier, in his 'Traité d'Histologie,' now being published, states distinctly that fat-cells are developed from round cells (corps globuleux), and gives drawings which are characteristically clear and trustworthy. He states that he is entirely opposed to Flemming's ideas, and holds that the round cells from which fat-cells are developed are special in their character even from their origin. Of other observers we may briefly note that Rollett holds the opinion that fat-cells are developed from small round granular cells. Virchow and Frey say that in the embryo they are developed from round cells, but they agree with Von Wittich and Foerster that in the intermuscular connective tissue and in pathological formations they are developed from spindle and branched cells. Czajewicz holds that they are developed from small, delicate, flattened cells, which look like spindle-cells when seen edgeways, but he does not even mention the wandering cells, although they were well known when he wrote. Toldt, again, believes that fat-tracts are glandular in their nature; and Ranvier agrees with him so far as to call a fat-cell a unicellular gland. According to Toldt, these glands (fat-tracts) develop from special centres in the embryo, whereas in the adult fat-cells are only developed from pre-existing fat-cells.

Turning now to our own researches, we wish first to state that we can see no reason for specially studying the growth of fat-cells in the embryo. They are not embryonic structures in the ordinary sense of the term, but are merely adjuncts to the processes of nutrition, whether found in adult or embryo, the process of development being similar in both; and in studying their life-history under the

Microscope we are studying physiological changes rather than special anatomical elements, changes which, in the space of a few days, may pass from the first appearance of fat in a cell to its full development, and subsequent decline and disappearance.

While the conclusions of many of the observers we have enumerated have been arrived at on the bodies of fishes, frogs, porpoises, &c., we have specially drawn our conclusions from investigations carried out on the smaller mammals, as bearing more directly upon man, and wherever possible we have compared these with preparations from the human body, with the result of finding complete identity throughout. Contrary, however, to the opinion of many authorities, we have found the serous membranes the most useful for our investigation, being enabled to utilize these by virtue of special methods of our own, which we shall describe. Of these membranes the most serviceable is the growing broad ligament of pregnant rats and mice; for the growth of this thin structure during their short term of gestation is so rapid, that the developing cells and other structures remain isolated, having no time to form themselves into the dense masses which seem to have foiled other observers. Indeed, confining one's examinations to sections of tissue, as recommended, would render it impossible to see the most interesting of the phenomena in the life of the fat-cell, which can only be recognized in uninjured membranes, and at the extremes of cell promontories or isolated cell groups or islands in such membranes.



A, Upper ring; B, Lower ring; C, Membrane between them.

Before ever the membrane is excised from the body of the animal, it must be evenly stretched once for all, so as to keep the lines of vessels apart from each other, and consequently the tracts of fat-cells which lie close to them clear for examination. Moreover, while the various reagents are gently applied, and the membrane is being continually subjected to examination under the Microscope, no fold must ever ruffle its surface, nor any object be touched by it until it is permanently put up as a preparation.

These desiderata are obtained by using the histological rings invented by us, of which we show specimens. They will be found to be most simple and useful adjuncts in the biological laboratory. These rings are always made in pairs, one fitting tightly upon the other, with a certain amount of taper in each; and when a piece of membrane is jammed between them, the whole has the appearance of a tambourine. They ought always to be made of vulcanite, as metals are acted upon by acids; bone, ivory, and other animal substances throw down salts like chloride of gold from their solutions;

while glass, wood, &c., are too fragile for use. We have them made of all diameters, but the most useful size for ordinary glass slides is seven-eighths of an inch in diameter.

When, therefore, we wish to examine the serous membranes, the animal must be killed gently by chloroform; indeed, as soon as it is insensible it ought to be even drenched with the anæsthetic, which seems, when thus given in excess, to anæsthetize the individual cells as well as the animal. No time should be lost by injecting the animal, as by doing so at first we missed some most valuable indications; but immediately after death the abdomen should be opened up to the fullest extent, a portion of the uterus or intestine seized with the forceps, and gently lifted up, so as to stretch the membrane which attaches it to the back of the abdominal wall. Upon one surface of this membrane the smaller ring of the pair is applied, and upon the opposite surface the larger ring is adapted, and pressed gently with a slight circular motion upon the smaller ring, so as not to rupture the delicate membrane, until it jams itself upon that smaller ring, with the membrane lying between them. It may now be snipped off with fine scissors external to the rings, thus separating it from the rest of the body of the animal; and we have then a miniature tambourine formed, in which condition the membrane remains until finally disposed of.

Our next step is to apply to either or both surfaces, with the greatest care and without any preliminary washing, a half per cent. solution of nitrate of silver in distilled water, and after a few instants' exposure to its influence, the preparation is carefully washed with distilled water, and exposed for a short time to a dull northern light, until the desired action of the silver has been obtained, as shown under the Microscope. We may now expect that not only have the various cells forming the membrane been fixed in the condition or shape they possessed during life, but that the shoals of wandering cells, which are continually groping over the free surfaces of the abdominal organs, will, as far as they existed upon the free surface of our piece of membrane, be firmly fixed *in situ*, and the whole may now be subjected to various staining processes.

Of these, by far the most suitable and generally used by us for such tissues is the process invented by one of us, and described three years ago in the Journal of the Quekett Club.

The tambourine membrane is first soaked for a few minutes in spirit, to deprive it of water, and a 2 per cent. solution of perchloride of iron in spirit is filtered upon it. After the lapse of a few minutes a few drops of a 2 per cent. solution of pyrogallic acid in spirit is likewise filtered upon it, and in a few minutes more, according to the depth of tint required, the whole may be washed in ordinary household water; a few drops of glycerine placed upon the membrane render it transparent, and it is

now ready for examination, or for being mounted permanently as a preparation.

Although this process of staining is by far the quickest and best for showing the development of fat in cells, it will be found advisable, more especially when studying their disappearance, to reverse the method, and, after treatment with silver solution, to treat the membrane first with osmic acid, to render the fat quite black, and then with logwood solution, to render the cells and their nuclei evident. But whatever processes the membrane may be subjected to, it will always be advisable to examine it from time to time under the Microscope, the membranous surface of the tambourine being placed uppermost on the stage; and, as may easily be conceived, it may thus be continually subjected to examination without touching anything or its receiving any injury whatever.

Instead of commencing with the ancestry of the fat-cell, we find it more convenient to start from the first appearance of fat-globules within one, and to trace their gradual increase until we reach the fully charged fat-cell. This condition is well shown in Fig. 1, from the broad ligament of the uterus in a well-nourished pregnant mouse. At *a* we see the first sign of fat making its appearance, as two minute oil-globules within a cell, one on each side of the cell-nucleus. At *b* we have a stage further advanced, and notice three fat-globules within a cell, each of the globules being larger than either of the two globules seen in the cell last described. In this way we may trace the progressive development of fat in *c*, *d*, *e*, and *f*, where the large fat-globules which fill the cells are on the point of running together to form the fully developed fat-cells seen in Figs. 4 and 6. Let us now return to cell *a*, and proceed in the opposite direction. All the cells we have referred to lie between the layers of endothelium covering both surfaces of the membrane, or, in other words, in the substance of the membrane itself. Now, there can be no doubt that cell *a* is of the same nature as cell *g*, in which no fat-globules have as yet appeared, and which lies like the rest in the substance of the membrane. But *g* is evidently similar to cell *h*, which is certainly a wandering cell lying external to the membrane, for it has placed itself in one of the natural holes which are so plentifully found in such membranes; it is evidently similar to the group of wandering cells seen near cell *e*, all of which, by the binocular Microscope, may be seen to lie on the free surface of the endothelium, over which they were travelling when the silver solution killed and fixed them in that position. Other minor features stamp these as being wandering cells; thus cell *i* possesses two nuclei, *h* has a purse-shaped nucleus where the one is about to become two, while at *j* we have the early stage or type of the newly born wandering cell; so that even without going further we might venture to conclude that fat-cells are developed from wandering cells

in the substance of the membrane (in this case), and that these ancestral cells are not special in their nature, as held by Ranvier, but are purely and simply wanderers.

The relationship between the fat-cells and wandering cells may be even more clearly traced in Fig. 2, from the mesentery of a rat, where, lying between, or rather opposite the space between, two groups of fat-cells, we see a portion of one of those shoals of wandering cells, which may always be found on the free surface of such membranes, lying sometimes like the lines of drift rubbish from a receding tide, and at other times in clusters or buds attached by a pedicle, if sufficient care has been taken not to rub or ruffle the surface of the membrane or rudely to wash them away.

The fact that these cells are to be found scattered over the free surface of such membranes, and unconnected with other structures, is clear proof of their being wandering cells; and when we can trace identity between them and similar cells becoming, or about to become, fat-cells lying between the endothelium-covered surfaces, the direct relationship between the two becomes evident.

In Fig. 2, with three or four exceptions, all the wandering cells depicted there lie on the upper free surface of the membrane; on the opposite free surface of the membrane there were quite as many, but to prevent confusion we have not drawn them. For the same reason, we have only drawn the endothelium outlines on the upper surface, except at cell *a*, where we have inserted in dotted lines the outline markings of the endothelium on the lower surface of the membrane, in order to show clearly that cell *a* lies between the surfaces in the substance of the membrane, and that it is identical with cells *c* and *d* lying on the free surface, and forms a link between these and cell *b* lying, like itself, between the endothelium-covered surfaces, and which, as is shown by the two fat-globules within it, is rapidly becoming a fat-cell belonging to the group of which cell *f* is a fully developed fat-cell.

It has been urged as a reason for holding the progenitor of the fat-cell to be a special form, distinct from the wandering cell, that the latter is globular and the former flat and round; but a glance at such a group of wandering cells as is shown in Fig. 2 lets us see both forms, with every variety of gradation between them. Young wandering cells like *d* have so little protoplasm round their nucleus, that they retain the globular form when exposure to cold or to silver solution has forced them to retract their amœboid processes and die on the spot.

Full-grown wandering cells, on the other hand, with abundance of protoplasm round their nucleus, like cells *c*, *c*, remain spread over a certain extent of surface when subjected to the same conditions as those affecting cells *d*, *d*. Every gradation of form may be seen between these two extreme types, and we may also note that, when-

ever a wandering cell is about to become a fat-cell, it develops a considerable amount of protoplasm or cell-substance proper, which increases likewise *pari passu* with the growth of the fat within it, so as to form a strong envelope for the great globe of fat in the fully developed fat-cell.

Wandering cells, therefore, like *e* and *f* and especially *a*, with a comparatively large amount of protoplasm, although apparently round when viewed from the front, are also flat, and when viewed edgeways they appear like long or spindle-shaped cells, thus causing and accounting for a certain amount of confusion in the views and descriptions of different observers; for in the thick subcutaneous tissue (unlike this thin membrane) in which it has been recommended to study the development of fat-cells, these cells are seen as often edgeways as any other way.

If we have succeeded in showing that fat-cells are developed from wandering cells, and that the hastily assumed difference between globular and flat round cells gives no ground for supposing that the progenitors of the fat-cell were special even from their origin, and if we have also succeeded in reconciling the views of Rollett, Ranvier, Czajewicz, and others, who have held respectively that fat-cells were developed from flat and from round cells, are we therefore to hold that Flemming and others, who have insisted that fat was developed in branched cells, are wrong in their views? By no means; and we hope to be able to show that they also are correct, and that perhaps the chief cause of disagreement between observers lies in the fact that, by different methods or modifications in methods of preparation, the same elements were shown in all the different forms referred to. Even at the risk of appearing prolix, we shall point out how slight modifications in preparation have changed our views slightly, and appear to justify the opposite opinions held by different observers.

When we first commenced this research some years ago, we were careful to bleed the animal to death, after making it insensible by chloroform, and after the blood had been withdrawn as much as possible, the blood-vessels were filled with a coloured injection, and the body was left to cool before we opened it to procure the membranes for our preparations. In this way the preparations from which Figs. 1, 2, and 4 were drawn, were made, and we believed that fat-cells were specially developed from round or flattened wandering cells. Some time afterwards, being in a hurry, we dispensed with the preliminary bleeding, injecting, and cooling, and found that we thus obtained singularly beautiful and illustrative specimens, especially when the animal had been drenched with chloroform after it was insensible. The vessels were still distended by fluid blood, and all the wandering cells within the membrane were found in a more or less branched condition, even when a large

number of fat-globules had become developed within them. In this way the preparation from which Fig. 3 has been drawn was made from the broad ligament of a pregnant mouse; and as an example of the rapidity with which such a specimen can be made by our special process, we may remark that within twenty minutes after the animal had been brought to us to be destroyed, it was killed by chloroform, opened, the membrane stretched on rings, silvered and stained black, clarified, and mounted as a permanent preparation.

Strange to say, when the first modification (by injection) was practised, the wandering cells were found in great numbers on the free surfaces of the membranes, as if during bleeding, injecting, and cooling they had endeavoured to make their way from the blood-vessels or their neighbourhood to the serous cavities; on the contrary, when the animal was quickly killed by chloroform and opened, they were seldom seen on the free surfaces. In this case, the jamming of the one ring upon the other keeps the blood-vessels distended by fluid blood, and the first preparation thus obtained is generally faultless, yet the very act of excising the rings with membrane attached opens the blood-vessels left behind, and thus a thin sheet of blood-corpuscles, scarcely noticeable to the naked eye, comes to be spread on the surface of the remaining membrane, and when silver solution is applied, the sheet of red blood-corpuscles becomes fixed *in situ*, and completely obscures the preparation. If, however, a jet of water is directed upon this membrane before applying the silver, these will all be washed away, but of course leaving the various cells in an altered condition, to be fixed by the subsequent application of silver. This shows the great advantage to be gained by using the silver on clean preparations, without preliminary washing, as this not only washes away the cells on free surfaces, but it also alters the forms of those left behind.

Fig. 3 may therefore be regarded as a typical specimen of wandering cells fixed in their branched condition, and in that condition they are becoming fixed cells wherever fat is seen developing within them. We there see the various stages of the development of fat within branched cells as clearly as they were seen within round cells in Fig. 1, and the different amounts of protoplasm developed round the branched wandering cells is as varied and distinctive as in the round wandering cells seen in Fig. 2. In short, we claim not only to have shown that fat-cells are specially developed from wandering cells, but that these wandering cells may appear to be round or branched cells, according to the process or modifications of processes by which they have been prepared; and we believe we have thus reconciled the views of different observers, as far as the shape of the parent-cell of the fat-cell is concerned, those views being erroneous principally because they

were too exclusive in their limitation to only one form of the parent-cell.

When, however, we pass from the mere expression of shape to the opposite opinions held by different observers regarding the essential nature of the parent-cells, we find it impossible either to reconcile these opinions or to agree with any one of them. We agree as little with Ranvier in supposing those parent-cells to be special in their nature, as we do with Toldt in supposing that only fat-cells can give origin to future fat-cells. Klein's idea of perilymphangeal nodules developing into fat-tracts, and fat-tracts being appanages of the lymphatic system, appears to us too far-fetched, so that there only remains for us to discuss how far it is correct to consider fat-cells as developed from the fixed cells of the connective tissue or from the adventitia of blood-vessels.

What is the connective tissue, and what are its branched cells? These are questions which we admit we are unable to answer, unless it be to the effect that we believe both terms to be no longer applicable to the cells or tissue to which they were at one time attached.

The term connective tissue, since it was first applied by Johannes Müller, has been modified out of all its original meaning by succeeding histologists, until at the present day no two histologists of eminence are agreed upon what constitutes that tissue.

Held at one time to include such structures as cartilage and bone, in whose fixed cells no one ever supposed fat to be normally developed, it is now almost confined to gelatinous, or what are called fibrous tissues in general, such as tendons, the subserous and subcutaneous tissues, &c. For our part, even if we acknowledge the branched cells in tendon, the cornea, and similar structures to be fixed cells, yet here also no one supposes that they can normally become fat-cells; and as regards the subcutaneous and subserous tissues in which fat-cells are generally found, we cannot admit that the branched cells found there are anything other than wandering cells, moving through the soft gelatinous matrix to enter into the formation of blood-vessels, fat-cells, or any of the other definite fixed cells found there, or leaving them in retrogression when that phase supervenes. Even should the term connective tissue be retained for the matrix or tissue referred to, we must hold the term fixed branched cells to be incorrect and inapplicable, and so far we are at variance with Flemming, Klein, and others, who speak of these as fixed branched cells. But in so far as we believe the wandering cells and the branched cells they refer to to be identical, we agree with them as to the parent-cells of the fat-cells. It is rather a curious commentary on the term fixed branched cell of the connective tissue that Ranvier, one of the latest and best of histologists, entirely denies the existence of such a cell, and endeavours to show

that the fixed cell of the connective tissue is a broad flat cell, "*cellule plate*," which, when applied to fibres, has the appearance, but only the appearance, of being a branched cell. Of course we are equally at issue with him in his conception of a fixed cell of the connective tissue, and believe that his "cellule plate" is only an exhausted fat-cell, such as we have drawn in Figs. 9, 10, and 11; and if anyone takes the trouble to compare our drawings with the drawings given by Ranvier at page 340 of his 'Traité d'Histologie' of his "cellule plate" (of which we have seen the original), he will see a wonderful identity between them, an identity which does not stop with appearance, but is continuous even in the physiological attributes he ascribes to it.

All these considerations show how dangerously vague a term is that of the connective tissue, and as we have already held that in those divisions of it which we have been considering there are no special fixed branched cells, it is clear that in our opinion no fat-cells can be formed from them.

The hypothesis advanced by Flemming that fat-cells are developed from the branched cells of the adventitia of the blood-vessels, seems to have met with general and, it seems to us, unmerited condemnation, for we have evidently here only an error of name and not of fact.

In the first place, as Flemming is not responsible for the term *adventitia of blood-vessels*, let us inquire what really constitutes this adventitia. Anyone who studies silvered preparations of the skin in mammals, cannot fail to be struck by the numerous and well-marked branched cells which lie specially upon the veins forming their so-called adventitia and stretching out from them for a considerable distance into the neighbouring gelatinous matrix, or, as it is called, white fibrous tissue.

The number of these branched cells seems to be considerably affected by various pathological conditions, so much so that we feel unable to admit that they are anything else than wandering cells clustering about the vein as if they were either about to enter or to leave it.

That fat should be developed in such wandering cells lying in so close proximity to nutrition, is not only reasonable, but in general accordance with our observations; for, as a matter of fact, fat-cells in a fat-tract found close to the lines of blood-vessels, seem to be developed from the wandering cells nearest to the vessel, and which would probably be called cells belonging to the adventitia of the vessel.

In Fig. 5 we have an illustration of the manner in which a fat-tract extends along a blood-vessel. In the cells there shown, the fat seen within them had been deposited to our certain knowledge within a period of twenty-four hours, and, although deposited in

previously existing exhausted fat-cells, it shows well the general plan of development. These fat-cells had developed peripherally along the blood-vessel *a*, first as a single row of cells *b*, *b*, lying along or upon the vessel, and afterwards externally to that single file as in the case of cells *c*, *c* and *d*, *d*.

The branched wandering cells from which these cells had originally been developed, might fairly have been considered as belonging to the so-called adventitia, although at the same time they were only wandering cells clustering round the vessel. So far, therefore, we are inclined to agree with Flemming in the identity of the cells and locality he refers to, although we cannot agree with him in holding that these are fixed branched cells, or that the development of fat-cells only takes place in the so-called adventitia, and in being too exclusive as to the locality of development; for, as seen in our drawings, fat-cells may develop either singly (Figs. 1, 3), or in islands (Figs. 7, 9, and 11) unconnected with any vessel whatever, although it is quite possible that the parent-cells only a short time previously formed part of the so-called adventitia of the nearest veins.

It is a matter of common observation that the tracts or masses of fat-cells lie close to the lines of blood-vessels, or, in other words, close to the centres of nutrition, and considerable importance has been attached to the question of the direction in which their development proceeds. This we consider to be a wholly unnecessary question, only brought forward by way of supporting certain erroneous hypotheses, and we only now notice it lest our silence be mistaken for acquiescence in them.

Laying aside Toldt's idea that the fat-tracts are developed as glands from special centres in the embryo, as being too extreme and palpably incorrect for serious discussion, let us pass to Flemming's hypothesis * that the fat-cells near blood-vessels develop first close to the vessels and are then pushed to the periphery by the growth of succeeding fat-cells, in other words, that development is from the centre of nutrition to the periphery. This view seems to be insisted

* Since the above was written, we have found that Flemming has recently published another article on fat-cells in vol. xii. for 1876 of the 'Archiv für Mikroskopische Anatomie.' That article seems to be in great part a defence of his former opinions, which had been attacked by Klein and others. He has, however, modified his views as to the development of fat-cells close to and from the adventitia of blood-vessels, in somewhat the same sense as we have put it. He also acknowledges that he was wrong in speaking of the whole of the protoplasma of the fat-cell outside the fat-globule as the cell-wall, and he corrects himself so far as to speak of it only as protoplasm, outside of which, however, he describes in very vague terms another, or, as he calls it, a secondary cell-wall or membrane not always necessarily present. In short, he has adopted Ranvier's idea of a fat-cell-wall, pure and simple, in which what remains of the original protoplasm is still to be seen on its internal surface, only he describes it differently as a secondary membrane formed outside of the protoplasm, a condition even more complicated and more untenable than his former opinion.

upon as a necessary corollary to his hypothesis that fat-cells are developed from the adventitia of blood-vessels, and Fig. 4 gives fair support to it, where cells *g*, *g*, in the early stage of development into fat-cells, lie at the very centre of nutrition, while the fully developed fat-cells *a*, *a* lie at the periphery. That this mode of development should be very common is easily accounted for by the fact that both wandering cells and surplus nutrition are most plentiful immediately external to the blood-vessels, from which they indeed probably come, and consequently fat-cells may most readily be developed there. But Fig. 1 shows equally well the more advanced fat-cells lying nearest the vessels, and the earliest stages of development of fat in cells at the periphery. All this shows that it is incorrect to limit the direction of development to one course as Flemming has done, or indeed to make a special question of direction of development, as we have shown that it may proceed from opposite directions or from any direction.

In Fig. 4 it will be observed that the fat is developing or being formed in two different conditions within cells, that while in cells *a*, *a* and *g* only one large globule exists, in cells *b*, *b* we have a large number of comparatively small globules appearing within one cell.

This really points to an important difference in the time or manner of fat formation within cells, which we did not perceive when the drawing was made, but which subsequent observations explained. If in a fat-cell the fat is slowly but steadily deposited, or has existed there for a long time, even if originally deposited in globules which have subsequently run together, we find in such cases only one large fat-globule filling and distending the cell. If, however, nutrition has been excessive and fat rapidly formed, we generally find it deposited as numerous globules, more especially if the cells in which it is deposited possess much protoplasm or were previously existing fat-cells which had become exhausted. Fig. 5 is an example of this condition, in which the exhausted fat-cells were probably in the condition of those shown in Fig. 9; but if the cells have passed into the granular condition shown in Fig. 10, the globules then appear to be imbedded in a granular matrix, as shown in specimens which we exhibit under the Microscope.

We mention these points on account of the importance they may have in medico-legal cases, such as the late Penge case; for the appearance of the globule not only gives us an idea of the quickness of its formation, but the pellucid or granular character of the matrix in which the globules are imbedded gives us an idea of the degree of exhaustion which had preceded the re-development of fat.

The latter conditions are very common in mice which have entered a trap while in a starving condition, and afterwards gorged themselves on the bait employed. In this way we have procured several specimens similar to Fig. 5, where in no case had

the trap been set above ten hours previously, showing how rapidly fat may become formed within previously exhausted fat-cells in these little animals.

It may also be well to state here that the normal shape of a fat-cell, when it is not distorted by the pressure of contiguous structures or fat-cells, is generally oval and sometimes round, as shown in Figs. 4 and 6, the irregularly polyhedral shape drawn and insisted upon by Ranvier being due entirely to distortion by pressure of contiguous cells, and therefore in no way representing the normal shape. The influence of pressure in distorting fat-cells may easily be traced in Fig. 6, where cells *a*, *a*, *a*, at the border of a fat-tract lying along the blood-vessels in the mesentery of a guinea-pig, have their free borders rounded off, while on the sides pressed upon by contiguous fat-cells *b*, *b*, they are becoming angular and irregularly polyhedral in shape, of the form indeed in which they are generally represented.

Hitherto there has been no question of a cell-wall or membrane, for all histologists agree that the wandering cell does not possess one, and indeed it is generally presented as the type (often under some other of its names) of a wall-less cell, whereas the fat-cell is almost invariably presented as the type of an animal cell possessing a true wall or membrane, and it therefore becomes of importance to inquire how far we are justified in accepting it as such a type. Ranvier and others, in tracing the development of the fat-cell from a wall-less cell, go so far as to localize the time when the wall is formed, and state that it is only when the fat-globules have pushed the nucleus from the centre of the cell to its periphery that the cell-wall begins to be formed.

Now, with all due deference to the opinions of other observers, we feel called upon to state that, even after careful searching and studying the fat-cell in all its phases, we find no evidence whatever of the existence of a special cell-wall, that is to say, in the sense in which the term is generally understood. We cannot admit that there is any change whatever in the nature of the cell-substance or protoplasm, although in fully developed fat-cells like those in Fig. 6 it has become so distended and attenuated by the mass of fat growing within it, that it appears to surround the latter like a thin sheet. Still that thin sheet is only unaltered protoplasm, and we shall afterwards see that, when absorption of the fat from the fat-cell occurs, the so-called membrane contracts upon the lessening fat, becoming thicker as the fatty contents become smaller in a way a formed membrane would not do, and when the fat wholly disappears, the cell-substance remains behind in the same protoplasmic condition in which it existed in the parent-cell. If any observer has observed before us the behaviour of the cell-protoplasm during absorption of fat, we cannot understand how he could reconcile

that behaviour with the existence of a formed cell-membrane, and indeed no better proof could be required of the entire groundlessness of the belief in a cell-membrane than that afforded by fat-absorption. This belief in a cell-membrane has arisen and been maintained by false analogy and erroneous histological methods, or through the interpretation of the appearances they produced. As a vegetable cell often possessed a cell-wall, so it was supposed that an animal cell ought to possess one, although the complete organisms of plant and animal are entirely unlike. Histologically it was, or rather it is at the present time, considered sufficient to treat fat-cells with ether, which dissolves out the fat from the fat-cells and leaves the empty envelopes behind, and these are held to be complete evidences of the existence of a cell-wall. It is somewhat surprising to find histologists at the present day, who make a *sine quâ non* of the use of fixing agents, admitting such a proof. Ether, like alcohol, is a fixing agent which first fixes the protoplasmic envelope and destroys its power of contraction, then dissolves out the fat within it.

Certainly the histologist in this case has made a membrane where one did not naturally exist, but the explanation is so simple that it is surprising that no one ever noticed the worthlessness of the test. Ranvier, while saying that this test is perfectly demonstrative, adds another of his own invention, which is equally misleading. By his well-known method of interstitial injection of a solution of nitrate of silver among the fat-cells lying in the subcutaneous tissue, he holds that he has been able to demonstrate the existence of a cell-membrane external even to the protoplasm distended round the fat. Under this treatment a dark membranous layer seems indeed to surround the cell, but here too the appearances are deceptive and the interpretation incorrect. When a solution of silver is allowed to come into direct contact with such cells, it forms such a layer where none existed before. This may easily be demonstrated upon an endothelium-covered membrane, as we have often done. If at one part the endothelium be removed where it covers fat-cells, and the silver solution be then applied, it will be found that the unprotected fat-cells show the dark pseudo-membrane where the silver solution had come in contact with them, while the contiguous fat-cells which were protected by endothelium show no such membrane, thereby proving that the supposed membrane is only an artificial production. Where the silver has thus only penetrated to a certain distance into the protoplasmic wall, the unaffected portion retains its normal appearance, and thus gives rise to the supposition that a part of the original protoplasm may often be seen lying on the inner surface of the supposed membrane.

The expression referred to, that the cell-wall only gets formed when the fatty contents have pushed the protoplasm and nucleus

to the periphery, is inaccurate, from the fact that protoplasm and nucleus are always peripheral to any fat-globule within the cell; and when by excessive distension the nucleus and protoplasm appear like a signet ring, the relation between the two still remains the same, and after absorption of the contained fat the nucleus appears to return to the centre of the cell-substance, as seen in Figs. 7, 8, 9, 10, and 11, although in reality the relationship has never altered throughout the cell life. We have now traced the fat-cell into its fully developed condition, as shown in Fig. 6, and seen that its parent-cell was the wandering cell, under which name we of course include white-blood cells, lymph, lymphoid, or lymphatic cells, migratory cells, embryonic cells, leucocytes, amœboid cells, and to these, by our own showing, the so-called fixed branched cells of the connective tissue and of the adventitia of blood-vessels; and we have also seen that these cells may be either globular, round, flat, spindle-shaped or branched, according to the position in which they are viewed, or whether they are fixed before or after they have had time to contract or retract their processes. With the fully developed fat-cell we reach the end of the first half of our studies, a task which ought to have been simple and short, but for the fact that it was encumbered with the divergent opinions of different observers. We have endeavoured to reconcile those opinions where possible, by explaining the causes of divergence, and in this, we believe, we have been not unsuccessful.

We now pass on to the second part of our studies, to show how the fully developed fat-cell returns into its original condition of a wandering cell, a task which will prove much easier and interesting than that of following development, for few observers have traced even the first part of the decline of the fat-cell, and none to our knowledge have witnessed the interesting appearances which herald its disappearance, so that we shall here only require to state the appearances observed by ourselves, and not to reconcile the divergent opinions expressed by others.

Part II.—*Retrogression of the Fat-cell.*

During the development of fat-cells we noticed that, as the fat increased within the cell, the cell-substance also increased *pari passu* with the amount of fat which it had to envelope. In absorption or retrogression of the fat-cell, we have thus two substances to get rid of before the cell can return into its original condition; but although these two substances, namely, fat and excess of cell-substance, developed at the same time, their absorption occurs separately; indeed the decline or break up of the cell-substance does not commence until some time after the complete disappearance of the cell-contained fat.

Both processes in retrogression can best be studied in the bodies of rats and mice or other small mammals; indeed the latter process can only be studied well in such subjects. Flemming and others have starved dogs and other large mammals for a long period, with the result that they have failed to observe the most interesting and essential part of the process. In rats and mice, more especially the latter, which are often trapped in a starving condition, the system seems to be so exceedingly sensitive to excess or deficiency of nutrition, that they may either fatten or starve within the space of twenty-four hours; the little animal from which Figs. 9, 11, and 12 were drawn, was found almost dead in a jar, into which it had fallen, and in which it could not have remained above twenty-four hours, yet the whole of the different stages of retrogression in fat-cells could be followed upon one preparation of its mesentery.

This great susceptibility to variation in nutrition is apt to introduce an element of uncertainty or confusion into the study of the process of retrogression upon them, for it often happens that the remains of fat-cells, which had been broken up some time previously, are to be found in a preparation where well-developed fat-tracts point to even excessive nutrition. The first changes, during the absorption of the contained fat, seem to occur in the condition of the fat itself, which, from being of a yellowish-white colour and thick consistency, becomes more transparent, watery, and slightly red in colour. These changes have been previously noted by other observers, who have compared the resulting fluid or fat to serum, although there is nothing of the nature of serum about it, for we find that under the action of osmic acid it blackens even more intensely than in the case of newly formed fat. When once absorption has fairly commenced, if nutrition continues deficient, it follows a steady course, characterized by diminution of the fatty contents and the contraction and thickening of the protoplasmic envelope containing them *pari passu* with each other. This process is illustrated by Figs. 7, 8, 9, and 10, showing different stages in different animals of the process of fat-absorption from fat-cells, and it will be found that in all the mammalia the process and appearances are the same throughout. Fig. 7 is from the body of a young man who died of cancer of the skin, under the care of one of us, at St. John's Hospital. He had entered the hospital only two months before his death, a plump and well-nourished individual, and said that previously he had never had a single day's sickness. His downward progress was rapid, as the whole of the skin of the left side of the thorax became gangrenous, and during the last few days of life he was kept under the influence of morphia, on account of his sufferings, and as he took little or no food latterly, he died much emaciated. Fig. 7 represents a part of his omentum, taken by permission immediately after death, and stained by silver and

pyrogallate of iron. It may be taken as a typical specimen of steady and unbroken absorption of fat from fat-cells, and it will be noticed that, owing to the locality and the absence of distorting pressure from neighbouring cells, as well as from their lying parallel to the surface, all the cells are assuming the oval, almond-like shape.

Fig. 8, again, is from the subcutaneous tissue of the body of a young man, who died after an illness of thirteen years and in the last stage of leprosy. It is prepared by treatment with osmic acid and picro-carminate of ammonia. It represents a more advanced condition of fat-absorption than that seen in Fig. 7; and although selected from a spot in a perpendicular section, where the fat-cells were by no means closely packed, yet evidence of distortion (rapidly disappearing, it is true) is to be seen in the angular shape of one or two of the cells. At other parts of the group not included in the drawing, many fat-cells were seen entirely destitute of fat. In neither case had the disease under which the patients suffered affected in any way the fat-cells. Although some observers have tried to make out a distinction between the fat-cells found under the skin and those found in serous membranes, recommending only the former for examination, yet it will be seen that the fat-cells in Fig. 8 only differ from those in Fig. 7 inasmuch as the former have been distorted by pressure of contiguous structures, while the latter show the normal and true shape of the fat-cells. Fig. 9, from the broad ligament of the mouse formerly referred to, shows a still further stage of absorption of fat, which has entirely disappeared from several of the cells *c, c* in the drawing. Some of these cells also have been exposed to some slight distorting pressure, and it will be specially observed that in general appearance they are identical with the fat-cells of the human body, as seen in Fig. 7, they having been prepared by the same process.

Certain observers have also stated that the difference between the fat-cells in man and the smaller mammals was so great, that the latter could not be taken as types of the former. To this statement we wish to give a complete denial; we have never been able to detect any difference whatever, not even sufficient to enable us to tell which animal they belonged to.

As from several of the cells shown in Fig. 9 the fat has completely disappeared, we may consider that in them we have reached the end of the first stage in the retrogression of the fat-cell, that, namely, which concerns the absorption of fat only; so before passing on to the second stage, let us make a few remarks relative to fat-absorption.

We find no reason to suppose that the different stages seen in the development of fat are represented in its absorption. We saw,

for example, that fat was first deposited in several or many globules within one cell, which afterwards ran or melted into one mass in the fully distended fat-cell.

In absorption of fat we find no breaking up into several globules of the one mass; but where the fat-cells contained only one mass, the mass grew smaller, but did not break up into globules, as seen in most of the cells of Fig. 7. When, however, the fat-cells were only in course of development when nutrition failed, as seen in several of the cells in Figs. 9 and 10, where the developing globules had not melted into one mass, these globules diminished together; in other words, single masses diminished as single masses, and multiple globules diminished as multiple globules.

The course or direction of absorption among fat-cells is better marked than the direction of development. The fat-cells of the mesentery, and more especially at the upper part near the pancreas, become empty before the fat-cells of the broad ligament, while in each membrane the cells farthest from the blood-vessels and from the neighbourhood of the parts of the blood-vessels farthest from the centre of the circulation, are the first to become emptied of fat. After the fat has disappeared from the cells, and the first stage of decline is completed, a period of quiescence ensues, during which little change appears in the condition of the exhausted cells.

It may be observed, however, that they seem to diminish slightly in size; they become more regularly oval or almond-shaped, and when viewed edgeways the fat-cell is seen to have become thicker in the centre, like an almond viewed edgeways.

Within the cell-substance the granules are seen becoming better defined from the transparent matrix containing them, and at the same time increasing in number. Suddenly, and without any particular change or warning, the granules begin to leave the cell in every direction, as if they had become endowed with the power of automatic locomotion which their mother-cell had lost on becoming a fat-cell. Not only does the sharp oval outline become lost in that mother-cell, but the nucleus also becomes nearly hidden by the mass of granules clustering round it like a swarm of bees round their queen. The swarm passes away on every side and in apparently no definite direction, the granules becoming fewer and more isolated the farther they pass away from the mother-cell.

This condition is well seen in Fig. 10, from the same animal as Fig. 9. We have there a small group of fat-cells forming an island apart from the great fat-tracts that lie along the contiguous blood-vessels. While the fat has disappeared from all the cells of the group, three of them, *a*, *b*, and *c*, have entered upon the condition of granular exodus, and the granules may be seen passing away from them in every possible direction. We see none of that appearance shown in drawings of an ovum which has been burst

by mechanical pressure, and where the vitellus is seen pouring out through the rent in the vitelline envelope. On the contrary, there is clearly no membrane here to rupture, and the granules appear to emerge from every point of the surface of the mother-cell; and we here desire to state that each of the departing granules has been drawn *in situ* by the aid of the camera lucida, and that we have in no way drawn upon our imagination in depicting this phenomenon. In Fig. 10 it will also be observed that there are stages in the granular exodus; cell *b*, for example, has retrograded further than cell *a*, and cell *c* further than cell *b*; or, in other words, the granular exodus has been going on longer, and a greater number of granules have left cells *c* and *b* than cell *a*, but the continuous change onwards in absorption can be better studied in Fig. 13, from the same animal and preparation as Figs. 9 and 10. In this Plate we are brought to what may be considered as the last chapter in the life-history of the fat-cell. In it the least advanced in retrogression are cells *a*, *a*, still undergoing the granular exodus. Cell *b*, however, has almost reached the last stage of this process, and in it a definite outline is again appearing, and the nucleus is again becoming distinct, being no longer hidden by the swarm of granules clustering round it, as in the case of the less advanced cells. Beyond cell *b* we have a group of cells *e*, which have probably belonged to a group of fat-cells similar to that seen in Fig. 10. From them the granules have almost entirely departed, leaving them in the condition of branched wandering cells, similar to those seen in Fig. 3, the faintly tinted protoplasm in both cases being almost destitute of granules, and visible apparently more in consequence of difference of refraction between them and the gelatinous matrix in which they lie than by any distinct colour or tint.

In fact, we have now come upon debatable ground, where there is room for discussing whether such branched cells are really the offspring or result of the granular exodus from fat-cells or *bonâ fide* wandering cells.

A certain number of granules can still be detected here and there within their protoplasm, but it is difficult to say whether these are a residuum of the original fat-cell or eaten as pabulum by the wandering cell. By long and careful examination, we have come to the conclusion that those cells *c*, *c*, are the remains of the fat-cells which we have thus traced back to their original condition, but we have considered it advisable to place the *contras* as well as the *pros* of the question before our readers.

It ought also to be borne in mind that other cells besides these contain granules, and that granular exodus is not confined to fat-cells, which are shown here as typical of a condition, and not as undergoing a change special to themselves. The blood capillaries

and vessels which had developed *pari passu* with the outlying groups of developing fat-cells, as indeed the special nutritive adjuncts of the latter, have no longer any *raison d'être* when their nurslings perish, and they consequently obliterate their canal, and the constituent cells separate and undergo a similar granular exodus to that seen in the retrograding fat-cells, although in a much smaller and otherwise almost imperceptible degree, as at *f*, *f*.

During the process of granular exodus in the fat-cell, a change was taking place in the condition of the nucleus, which only becomes apparent when, as shown in cell *b*, the greater part of the granules which obscured the nucleus have left and allowed the nucleus to become visible.

In the wandering cell, the nucleus stains intensely by colouring agents, and is generally more or less globular in shape, except when proliferating. When the wandering cell becomes a fat-cell, we see that, as the protoplasm becomes distended by the fat within, the nucleus also seems to become stretched out into a flat circular or oval form, being thinner if greater in superficies, and staining much less intensely than formerly by staining agents. Even in retrogression the nucleus maintains its flat and circular condition, as it seems to pass back to a position in the centre of the cell-substance, and continues in that condition till the granular exodus obscures it. When it next appears, as in cell *b*, it has become globular, and smaller in superficies, and begins to stain more intensely, comes back indeed to the condition of the nucleus of the wandering cell, so that no distinction can be made between them.

The point of greatest importance in this inquiry is the nature or character of those granules which we see leaving the cells and travelling through the gelatinous matrix of the membrane, apparently by virtue of their own power of locomotion. Indeed the end of these studies only opens out to us the commencement of other more minute, more delicate, and more important researches. What, in the first place, is the typical shape of the granules? The powers of the Microscope used in making the drawings 800 diameters, only showed them as bright refringent points, staining slightly by the black staining fluid used in the cases mentioned.

Moreover, to be able to fix their natural shape, they ought to be studied in their living condition, upon the warm stage under the Microscope, to see if, like wandering cells, they alter their shape during life or during their locomotion, if such can be observed. Even during their dead condition (chloroform having been plentifully used in killing the animal, so that we might hope that, like the wandering cells, they were fixed in their living shape), with specially high powers of the Microscope, we can see that many of them are oblong in shape but round when seen edgeways, and sometimes two or three are attached together like beads. All these

points, however, ought to come into a special inquiry into their life-history, so that we have considered it advisable at present merely to draw them in their general positions, shape, and size, as seen under the power used in making all the drawings in this research.

But of far greater importance than their shape is the character of the substance composing these granular bodies, and this, we think, we have been able to ascertain satisfactorily, as far as their biological character is concerned.

As may well be conceived, the first point of importance to settle was whether these were fatty or protoplasmic in their nature. If, as was likely, they were fat-granules, little importance was to be attached to them; but if, on the contrary, they were protoplasmic in character, they were all-important as a key to the past and an explanation of the future.

To decide this point we had to vary our methods of preparation and, instead of using the pyrogallate of iron, we treated our membranes with ether, logwood, carmine, indigo, purpurine, and eosine, with and without osmic acid, and the result was unmistakable. Osmic acid did not blacken, while colouring agents stained, logwood being prominent among the rest in the intensity of its staining, showing that these granules were protoplasmic in character and not fatty.

The character stamped upon them by staining tests, as well as the power they appeared to possess of moving off at pleasure from the parent-cells by their own inherent power, and as we shall afterwards see of probably moving back again when the conditions were reversed, show us that we have here to do with something specific in biology, something vastly more minute, and a stage more elementary than the composite body called a cell; something which lives and moves and has its being independently of the cell, and to which we are called upon to assign a specific sphere in nature. Have we here germs, the micrococci, the zooglœa, the spores, fungi, bacteria, or the spores from which bacteria are developed in these living atoms? It is impossible to evade the conclusion that had these been observed in sections of tissues, where their connection with the cell or its nucleus could not be traced, more especially in any specific disease, they would indubitably have been ascribed to some of the foregoing classes, and (perhaps not without reason) the most serious conclusions might be drawn from their presence. We have no doubt that they furnish a key to the alleged discoveries of some of the above-named classes of organisms in certain specific or infective diseases in the past, and they may probably furnish an explanation of many infective processes in the future.

We may also mention here, with reference to a recent biological mistake in the character of germs that, whether treated with or

without alcohol, and indeed by all kinds of modifications of method, the result was always the same. At page 13 of his work 'On the Lower Organisms,' in endeavouring to account for the presence of bacteria within the living body, Dr. Bastian says:—"We must imagine that when the vital activity of any organism, whether simple or complex, is on the wane, its constituent particles (being still portions of living matter) are capable of individualizing themselves, and of growing into the low organisms in question. Just as the life of one of the cells of a higher organism may continue for some time after the death of the organism itself, so in accordance with this latter view, may one of the particles of such a cell be supposed to continue to live after even cell life is impossible."

This hypothesis of Dr. Bastian's is so exactly applicable to the granular bodies we have described, that we have ventured to quote him, as he expresses even better than we could ourselves the opinions we hold and wish to put on record.

We believe that in them we supply the missing link between cellular and germ pathology, and its bearing on the causation of disease will become more apparent when, at another time and place, we have an opportunity of showing that granular exodus is not confined to healthy cells, but that at least in one virulent disease we have characteristic granular breaking up of its cells throughout the body, and in that the explanation of its eminently contagious character.

But the interesting phenomena to be observed in the life-history of these organisms by no means cease with their leaving the parent-cell in the condition of the wandering cells seen in Fig. 13. Even in that direction they may pass beyond the stage seen there, and thus we find that the whole of the fat-cells forming a great fat-tract may pass away, leaving the vascular network which supplied them still existing, or they may still be observed there as numerous granular patches, each with its own nuclear centre which it is about to leave, and which in turn is about to leave the neighbourhood of the blood-vessels, as in Fig. 12.

Even at this juncture, if nutrition becomes again abundant, a complete change takes place in the action or plans of those granules. In that case they seem at once to return to the nucleus they were leaving or had left. They surround that nucleus on every side, and, when logwood staining is used, we find that, although that nucleus (where it can be seen) is stained as intensely as the neighbouring nuclei, yet the clustering granules stain so intensely purple as completely to hide the nucleus from view, as shown in Figs. 5 and 14. Then comes another consideration: the granular cells staining intensely by logwood come to be seen not only near vessels where no fat-cells had ever existed, but also far away even from vessels, in the centre of non-vascular tracts, which they could only have reached

by journeying as wandering cells. That they have this property, we think we can demonstrate satisfactorily by means of specimens which we show to-night.

If, in the first place, we start with cell *a*, Fig. 10, which seems to have left the group of fat-cells shown there, we can pass on to another example, Fig. 16, where four of such granular cells can be seen lying within a natural hole of a membrane, like cell *h*, Fig. 1, and lying, moreover, within a group of wandering cells for which they cannot possibly be mistaken; for the large oval contour filled with granules, a nucleus sharply defined and of a reddish colour (when stained by pyrogallate) contrasts strongly with the blue-black polynuclear condition of the wandering cells surrounding them.

Only one link is missing, and that also we supply, by showing in *a*, Fig. 15, such granular cells in the branched condition, moving along by the side of blood-vessels, and contrasting strongly with the transparent delicate branched cells *b*, *b*, near them.

It would, therefore, appear that when from a fat-cell all the fat has become absorbed and it has passed into granular retrogression, the faculty of locomotion is restored to it, that indeed it is in the condition of a wandering cell, plus the granules which it contained. But it would further appear that, while wandering and while its own granules are moving off from it, a supply of nutrition checks the granular exodus without checking the cell wandering (or exodus as regards the fat-tract), and then the granules may cluster round the nucleus in every possible form of irregularity, looking like the peripheral crystals in a lump of sugar. Gradually, however, these granules seem to melt into the substance of the cell, and it is again finally seen as a round or oval flat cell with sharp border and granular contents, which gradually become less granular, until the granular cell, the quondam fat-cell, becomes indistinguishable in appearance from any other wandering cells and, as we already have seen from its presence in the natural hole of a membrane and therefore on its free surface, it has also the same nomadic faculty, and indeed with that faculty we see no reason why it should not be discovered within blood-vessels where we have not yet looked for it. The time taken to effect all these changes is comparatively long, and we have not yet been able to fix a limit. We believe that a fortnight is not sufficient, and this fact is apt, as we have already noted, to introduce a complication into the study of this question; for just as it seems the rule that a mouse may be reduced often to the point of starvation while at large, the vestiges of such granular cells are scarcely ever entirely absent from some preparation, although we are able to show two or three in which they have not been found to exist. When, moreover, we take into consideration the fact that other cells beside fat-cells have the power

or fate to become granular, and, moreover, that other processes besides starvation will reduce even the fat-cell into the granular condition, we may form a fair idea of the difficulties surrounding this research and the liability to errors which it possesses.

Apart from the question of disease, if a tame rat be put into a cage with some strangers, these latter, if they are powerful enough, will often so maltreat the new-comer as to reduce it to a skeleton, or even kill it outright, and then the same phenomena of fat-cell absorption may be witnessed. Although young rats while they are being suckled are generally plump and fat, they rapidly become lean when weaned and forced to provide for themselves instead of being dependent on the mother's milk. In such cases, even although food had been continuously supplied, we have found the fat-cells exhausted and granular cells abundant, which could only be accounted for by the change in nutrition subsequent to weaning. Even more interesting is the condition of the fat-cells during excessive lactation, and the bearing which this has upon the same condition in the human female. In rats and mice, pregnancy is accompanied by a great accumulation of fat in the tracts near the blood-vessels, as if in preparation for the demands about to be made upon the mother by her nurslings. A short time ago a female mouse, having been trapped, was brought to us to be destroyed, and we afterwards noticed that it was extremely lean, and that its teats were pendent and flaccid, as if it were nourishing a large litter of well-grown young ones, which we afterwards proved to be a fact. From this animal's broad ligament and mesentery specimens were prepared which showed all the stages of retrogression, similar to those seen in Figs. 9, 10, and 13, although, from the immense number of exhausted fat-cells near the lines of blood-vessels, it was evident that, shortly before, the animal had been extremely fat, but it had been brought down to a condition identical with that found in starvation, by the excessive demands of its young upon it. We have thought it unnecessary here to enter upon any speculation as to the channels by which the granules of protoplasm move off from their parent-cell; by the aid of the binocular Microscope and one preparation whose endothelium is marked by silver on both surfaces, it is easy to decide that the granules are moving off through the soft gelatinous matrix which forms the membrane. They move off in every direction and by no definite channel, and lest some one should invoke the presence of lymphatic radicles as a channel of exodus, we can only say that, after having made a speciality of the search for lymphatic radicles or vasa serosa, such channels are purely mythical, and have no foundation in fact. They may possibly pass away finally by the blood-vessels or lymphatics, or even more probably they may be absorbed or appropriated by the wandering cells, and we can from this easily imagine

how, by the absorption of granules from diseased cells by wandering cells, a specific disease might quickly become generalized throughout the system.

One word more as to the behaviour of the exhausted fat-cells not yet passed into granular exodus, when nutrition again becomes abundant. If in the condition of the cells seen in Fig. 9, they simply fill the already prepared mass of protoplasm with numerous fat-globules, as seen in Fig. 5. But if the cells have become granular, like those seen in Fig. 10, when about to break up, then they still fill up, as in Fig. 5, only that in this case the fat-globules seem imbedded among granules. Of this condition we show a specimen, Fig. 11, which affords inverse proof of the connection between granular cells and fat-cells.

In terminating this long paper, we wish to observe that we do not pretend to have completed this question of retrogression, but rather to have only opened it out. Conscious of our many imperfections, we are prepared to find our conclusions modified or reversed subsequently by others or by ourselves. We are also aware that several collateral conditions remain to be investigated; such, for example, as whether the supply or deprivation of water affects the retrogression of the fat-cells in starvation, or whether gradual or sudden deprivation of nutrition has the same result or effect on the fat-cells. These are points which would require to be settled by direct experiment, if one has not the patience to wait for accidental circumstances. We have the patience to wait rather than experiment, and when opportunity offers and we find anything new or anything incorrect, we shall not be so tardy in making it known as we have been with this research, which has been spread over an interval of above four years, but which we have endeavoured to bring up to date.*

While the foregoing was passing through the press, two remarkable communications were made on May 6th and 20th to the Pathological Society. The first of these, "On the Occurrence of Micrococci underneath Antiseptic Dressings," by Mr. Cheyne, a pupil of Mr. Lister, and supported by him, mainly concerned the cultivation in vegetable infusion of micrococci from the matter obtained from wounds treated antiseptically, while the second was the report of the Committee on Pyæmia, and was largely illustrated by microscopical specimens of tissue in that.

In the preceding pages we have spoken vaguely of the identity of the granules we have described with many of the so-called specific organisms, because we were aware that different people held different opinions as to what constituted those supposed organisms. The high authorities who brought micrococci before the Society, however, gave us a definite standard of comparison, and we now assert with confidence that all those micrococci were nothing other than the

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* A short account of this research with microscopical demonstrations was given by Mrs. Hoggan before the Naturforscher Versammlung at Cassel in September, 1878, and her remarks were published *in extenso* next day, on pp. 56 and 57 of the 'Tagblatt.'

granules formed from cell protoplasm in the manner we have described. The specimens illustrating pyæmia especially, showed micrococci both in free masses and within cells of the kidney, almost identical with those shown in our preparations.

In the discussion of the questions referred to, it was assumed that the so-called micrococci were specific independent organisms from without the body, and the chief interest turned on such questions as how they managed to enter underneath the dressing or into the body, whether they could exist in the body, or what specific influence, if any, they might have there.

All reasoning therefore might, however, seem superfluous if it could be shown that, instead of being specific independent organisms from without, the so-called micrococci were merely minute atoms of the protoplasm of the cells within the body, formed as we have described, and that according as they were the result of a physiological or a pathological process, so would their effect be when introduced into the system. In more specific terms we might consider that the particles resulting from the disintegration of the protoplasm of fat-cells would be harmless, while those resulting from the protoplasm of cells in glanders, where we have also observed this process, would be most malignant in their effect when introduced into the system; and the same might be said of those particles so clearly shown within and outside the cells in pyæmia.

XX.—*On some Applications of Osmic Acid to Microscopic Purposes.*

By T. Jeffery Parker, B.Sc., F.R.M.S.

(*Read* 12*th March*, 1879.)

Since the introduction of osmic acid amongst the reagents of the histologist, it has been used for very various purposes. Its chief virtue depends on the fact that it kills and hardens protoplasmic structures with the least possible amount of shrinkage, and that it stains fat of an intense black colour. The former property has rendered it of great value in embryology, in the study of *Infusoria*,* and for many of the more delicate animal tissues; the latter gives it its pre-eminence in bringing out the ramifications of the finer medullated nerves, and the structure of adipose tissue.

Recently, as the Fellows of this Society are aware, Graber has made use of osmic acid for the preparation of insect structures, with very signal success; Flesch, also, recommends the employment of a mixture of it with chromic acid for preparations of the cochlea and retina; and Dr. Marshall has used a similar mixture for the preservation of chick embryos.

I must apologize for bringing my very limited experiences before the Society, but as some of my osmic acid preparations seem more successful than those of similar objects prepared in any other way, I venture to think that some account of my experiments may not be without interest.

Perhaps the most successful preparations I have yet succeeded in making with the aid of osmic acid, are entire specimens of a little glass-crab (*Phyllosoma*), the larva of the macrurous genus *Scyllarus*. The specimens were sent last July to Professor Huxley, by Mr. Lloyd, of the Crystal Palace Aquarium, where the larvæ were hatched out.

In the case of these *Phyllosomæ*, ten minutes' immersion in a 1 per cent. solution of osmic acid, and subsequent treatment with alcohol of gradually increasing strength, commencing with 50 per cent., and ending with absolute, served not only to harden the tissues, but to differentiate them in a very striking manner. The immense central nervous system was stained jet black, and stood out with diagrammatic clearness; the muscles, glands, &c., assumed a greyish-brown colour, the striæ of the muscle-fibres becoming remarkably distinct. An immersion of five minutes was in some respects still more successful, although less striking; the nervous system in this case took the same grey-brown colour as the other soft parts, the fibrillation of the nerves and the nuclei

* Apropos of Dr. Pelletan's paper reprinted in this Journal, vol. i. p. 189, I may mention that osmic acid is recommended for the instantaneous killing of Infusoria in Huxley and Martin's 'Elementary Biology,' p. 94.

of the nerve-cells becoming very clear. The cells of the liver and green glands, and those of the hypodermis were also brought into view in a manner that left little to be desired for clearness.

By no means the least important point about these larvæ is that, delicate as they were, they could, after the treatment described, be clarified with oil of cloves and mounted in Canada balsam, with little or no shrinking or distortion.

For *Daphnia*, I have lately found the same treatment a decided success. The heart, alimentary canal, ovary, and appendages are well brought out; the nervous system not so well, owing, I suppose, to its containing less fatty matter than that of Phyllosoma, and consequently not being acted upon to the same extent by the acid. For entire specimens an exposure of ten minutes to half an hour in 1 per cent., or of twelve to twenty-four hours in $\frac{1}{10}$ per cent. is sufficient; but for dissected specimens, to show the separated appendages, a day in 1 per cent. is not too much, the chitin becoming stained of a light brown colour by the long exposure. In one specimen acted on for this time I was fortunate enough to get the heart dissected out of its pericardium, and found that the organ showed very perfectly the beautiful arrangement of muscular fibres figured by Claus.* It must be remembered that after twenty-four hours' exposure to a 1 per cent. solution of the acid, the Daphniæ appear perfectly black to the naked eye.

For *Cypris*, *Cyclops*, &c., the same process is equally good for the preparation of specimens for dissection; but very little is shown when the animals are mounted whole.

The acid is a great success for preparing the mouth parts and other appendages of *Asellus aquaticus*. The animals should be placed entire in a 1 per cent. solution for about a day, and then treated with alcohol of gradually increasing strength. They become jet black to all appearance; but when the appendages are dissected off, clarified, and mounted in balsam, they are seen to be stained of a rich brown colour, their muscles are brought out with perfect clearness, and their finest setæ well shown up. The same specimens unstained are so transparent as to be almost invisible, and such colouring matters as carmine and hæmatoxylin are anything but successful.

I have made very few experiments with insects, but those I have are sufficient to show how valuable this method is for the preparation of mouth parts, salivary glands, Malpighian tubules, &c., and how it ought, for the former, entirely to replace the somewhat barbarous method of treatment with potash or with turpentine.

The only other application of osmic acid to which I have to draw attention, is for the preparation of delicate vegetable structures. The most important experiments I have made in this direction are on the

* 'Zeitschr. f. wiss. Zool.,' xxvii. pl. 26.

terminal bud of *Chara;* and for this I have found it so successful, that I have no doubt of its usefulness for other structures of a like nature. The buds were placed in acid until they appeared black, and were then treated with alcohol as described above. They were then clarified with oil of cloves, and imbedded in cacao butter, and the sections cut were mounted in balsam. The method is extremely good for the younger parts of the bud, such as the apical cell, smallest leaves, &c.; but the oil of cloves and balsam cause a good deal of shrinking of the older cells: it might possibly be better to imbed in glycerine jelly, and to mount the section in glycerine. The staining of these objects is very successful; the acid seems to have been taken up by each granule of the protoplasm, and there to have been decomposed, giving the granule the characteristic grey colour. A mixture of osmic and chromic acids (chromic acid, 0·25 p. c., 9 parts; osmic acid, 1 p. c., 1 part) answers, in some respects, even better than osmic acid alone for this purpose.

In this, as in all the former instances, one great advantage of the method is that hardening and staining are performed in one operation.

XXI.—*Is not the Rotiferous Genus Pedalion of Hudson synonymous with Hexarthra of Ludwig Schmarda?*

By Julien Deby, F.R.M.S.

(*Read 8th January*, 1879.)

Looking lately through the plates illustrating Ludwig Schmarda's 'Zur Naturgeschichte Ægyptens' (Vienna, 1854), I fell accidentally upon the figure of an extraordinary rotifer which reminded me forcibly of Dr. Hudson's *Pedalion*. From the imperfect figure, plate iii. fig. 1, of Schmarda's work, I referred to the text for fuller details, which are to be found on p. 15. We see there that the rotifer called *Hexarthra polyptera* was discovered by Schmarda on the 19th of March 1853, in a small pool near the ruins of El Kab, in Egypt. The water was brackish to the taste, and the animal lived in it in shoals or "swarms." Although at the first aspect Schmarda thought he had to do with some small crustacean, he soon discovered the true position of his animal in the family Hydatinea.

His examination, although insufficient for clearly establishing identity of generic characters between *Hexarthra* and *Pedalion*, is, however, sufficiently detailed to allow of great doubts being expressed as to the right of existence of the latter name. The differences between Hudson's and Schmarda's descriptions reside principally in the incompleteness of the details given by the latter, and are consequently differences of omission rather than anything else. Schmarda's work being rather difficult of access, I have translated therefrom his description in full of *Hexarthra polyptera*, which I reproduce for the sake of comparison with Dr. Hudson's careful and elaborate papers, published in 'Month. Micr. Journ.,' vol. vii., 1871, p. 121; in 'Quart. Journn. Micr. Sc.,' vol. xii., 1872, p. 333; and in 'Month. Micr. Journ.,' vol. viii., 1872, p. 209:—

"The body is transparent, colourless, and represents a blunt cone, at the broad end of which are situated the rotary organs. These last are large, with numerous long cilia, and are so attached as to form a right and a left group. Two globular red eyes are seen in the middle of the forehead, not far asunder. The digestive apparatus is very distinct; an undulating (flimmernde) slit (mundspalte) leads into a conical œsophagus, moved by four muscles, and carrying two semicircular jaws, each of which is furnished with seven teeth. The build of the masticating apparatus has some resemblance to that of Triarthra. The stomach is short, but rather broad, and leads into a cylindrical, many times constricted intestine, which narrows at its lower end. The absorption of carmine was easily obtained. At the upper portion of the intestine two pancreatic glands, which are divided into two lobes, are seen to open. The organs of respira-

tion consist in two long, winding vessels on the sides of the body. At the anterior extremity exists another system of vessels, forming a great vascular ring, from which branches are thrown out. As regards organs of generation, the ovary alone was recognized with certainty. A second small, bladder-like organ is perhaps the testicle. Eggs of various sizes and stages of development were contained in the ovary. The ripe eggs were light green, and were carried about at the posterior end of the body. The motions of the embryo, the vibration of its cilia, and the motions of its jaws, were frequently observed before leaving the egg-shell. The organs of the senses consist in two round eyes, filled with a carmine-coloured pigment.

The organs of locomotion are very peculiar and complicated. They consist in three pair of oars or fins. The first pair is the most powerful, and takes its origin high up on the outside of the abdominal face. It is conically pointed, has centrally on each side four teeth, and divides at the tip into five pair of small plumed appendages or fins. Two clearly marked muscles, striated transversely, run through the whole length, giving off branches to the appendages. The second pair of limbs is somewhat smaller in all its dimensions, and is inserted deeper and more inwardly. The eight teeth on the sides are shorter, and the tips only carry eight appendages.

These limbs only carry a single central muscle. The third pair springs from near the middle line of the body; on its lower third, it is the smallest and weakest of the whole, and only one muscle is discernible in each limb. The motion of these organs is very active and energetic, as well as various in direction. Not only do these animals swim with great swiftness, but, just as in Polyarthra, Triarthra, and others, they have the power of leaping. Besides these oar-like organs and the rotary organs, both long and circular muscles aid the movements of the body. I kept the creatures alive until the beginning of April."

I advise those interested in the study of the Rotatoria to have a look at these figures of Schmarda's, as no types of this class of animals are more interesting from an evolutional point of view than Pedalion or Hexarthra,* if this latter be really distinct from it.

* Schmarda's original work was laid before the members of the Society by M. Deby.

XXII.—*Note on M. Deby's Paper.*

By C. T. Hudson, LL.D., V.P.R.M.S.

(*Read 9th April*, 1879.)

In the above paper M. Deby says:—"The differences between Hudson's and Schmarda's descriptions reside principally in the

Fig. 1.

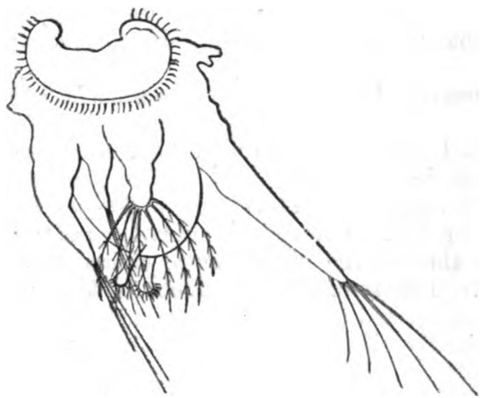
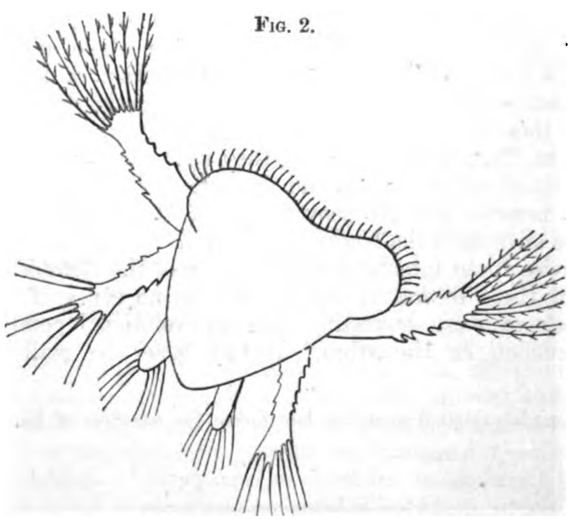


Fig. 2.



incompleteness of the details given by the latter, and are consequently differences of omission rather than anything else."

An examination, however, of the two figures here placed side

by side, mine (Fig. 1) of Pedalion, and M. Schmarda's (Fig. 2) of Hexarthra, will show that M. Deby's statement cannot be maintained, especially as M. Schmarda's written description exactly tallies with his figure in the poiuts to which I wish to call attention.

These are, that both M. Schmarda's description and his figure represent his rotifer as having *two* limbs of equal size much bigger than the rest, and that all six spring from the *same side* of the rotifer.

Now, Pedalion has *one* of its six limbs much bigger than all the rest, and it is situated on the *opposite side* to the other five.

M. Schmarda's drawings are probably but rough ones; but making every allowance for this, it is surely impossible that he could have been guilty of two such blunders as M. Deby gives him credit for.

No doubt the two creatures belong to the same family; but they are generically distinct.

I strongly suspect M. Schmarda's "great vascular ring" to be nothing but the muscles at the neck, and the "testicle" he speaks of, to be probably the contractile vesicle; but it is of little use to criticize hypothetical mistakes, so I will not pursue the matter further.

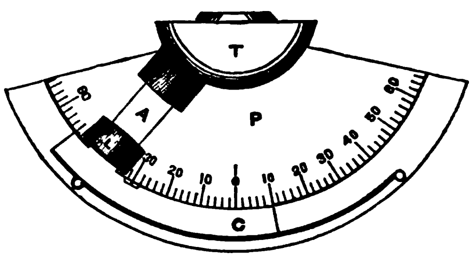
XXIII.—*An Illuminating Traverse-Lens.* By Robert B. Tolles, of Boston, Mass., U.S.

(*Read* 9*th April,* 1879.)

With the advent of objectives of increased interior angle of aperture, the indispensableness of equivalent accessory means for the illumination of the object became immediately evident.*

In my first construction of such object-glasses, I therefore required to provide means which proved so suitable that I have adhered to their use to the present time.

The first appliance was a deep plano-convex lens, centrally mounted below the object and having its centre of curvature in the object-place. Afterwards, I adopted a plano-cylindrically convex lens, equal to a hemisphere less the thickness of the object-slide, which was placed in immersion contact with the base of the slide so that the object itself formed the centre of curvature of this illuminating lens. Around the convex surface of this central lens moved a shutter to regulate and limit the access of light, and it was provided also with a small plano-concave lens which, applied by its concave to the convex surface of the larger lens by immersion contact, cancelled the refracting surfaces and allowed a perpendicular *beam* of light to reach the suitably immersed object without refraction.†



The device in a more complete form is represented in the annexed figure, where P is the basilar plate of the whole traverse system, having a circular groove and track in which the carriage C moves. On a projecting arm A of the carriage C are mounted whatever appliances are to be used to modify or direct the light upon the traverse lens T in the direction of the object at the centre of the system.

In the figure the concave lens N is shown in position on the arm. Thus situated, the interior convex and concave surfaces being of no effect, the two exterior plane surfaces of *the traverse system* constitute it a prism, and every slightest movement of this

* See 'M. M. J.,' July, 1871, p. 38. † Ibid., May, 1873, p. 213.

concave facet lens on the traverse lens T would *give a different prism* to infinite variety. In this arrangement, the concave mirror can be used in the ordinary manner and condense light enough upon the object for all ordinary purposes. The full interior aperture of a dry objective would be reached at the very convenient obliquity of 41°, i.e. at less than the critical angle, or angle of total internal reflection between crown-glass and air. L is a double-convex condensing lens, that may be placed at about its principal focal distance from the object.

For a condenser, with the size of apparatus as drawn in the figure, a simple lens of 1¼ inch focus and about ten (10°) degrees of aperture is convenient, and if the lens is movable along the arm A, it can be focussed readily on the object, the position being fixed by inspection. This would be well for parallel rays. If diverging rays are used another lens of two or three inches focus, mounted on the arm A, will conveniently take up the rays from the radiant at the distance of the focus of this supplementary lens.

The plate P is graduated on its circular edge, as in the figure, to two degrees, and the arm A has a swing of seventy degrees of arc each way from the axis of the Microscope. An index-line is marked on the bevelled edge of the carriage 10° from the axis of the condenser, which must be added to or subtracted from the real obliquity of the illuminating rays.

It is obvious that any observation made and duly recorded as to its conditions, as of obliquity of incidence of illuminating pencil or ray, form of the pencil or beam, focal length and distance of the condenser, such observation could be successfully repeated. The record of the obliquity of the most oblique rays reaching the object directly and giving view of it at the eye-piece with luminous field, would express the "balsam" aperture, or more correctly, the half interior aperture of the objective when the front lens of the objective and the traverse system are of glass of similar refraction.

Having thus the "balsam" angle we readily calculate or learn the corresponding angle for glycerine, or water, or any medium of which we have the index of refraction. A corresponding notation, perhaps for air, might be engraved in juxtaposition on the basilar plate.

XXIV.—*On the Occurrence of Recent Heteropora.*

By Arthur Wm. Waters, F.G.S.

(*Read 14th May*, 1879.)

Plate XV.

In looking through some of the British Museum recent Bryozoa, I several times came across portions of round branches from the neighbourhood of Japan, and upon examination some were seen to be Myriozoum; but the structure of others, similar in form, was upon first sight a puzzle, for broken sections seemed to show transverse markings like septa, so that I was in doubt as to what this might be, and it was necessary to make transparent sections before the appearance was explained, but then the tubular cyclostomatous nature was quite clear, and it was interesting to find a Cheilostomatous (*Myriozoum subgracile* d'Orb.) and a Cyclostomatous Bryozoon from the same locality, so similar in habit that they were placed together as the same species, not in one case only, but in several.

As is the case in all Cyclostomata, the shell-walls are perforated by small holes, and the shell thickening between these holes gives sometimes a beaded appearance (Fig. 4) to a section of a cell-wall; and it is to the irregular thickening of the shell causing well-like depressions round these holes that the peculiar appearance of transverse lines is due.

Mr. Busk, in the 'Crag Polyzoa,' page 122, speaks of partial transverse nearly equidistant septa in Heteropora, and Mr. J. Haime figures most distinct septa in his *H. pustulosa.** These

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EXPLANATION OF PLATE XV.

Fig. 1.—*Heteropora pelliculata*, natural size. (The upper branches are drawn slightly too long.)

Fig. 2.—Longitudinal section of ditto, × 25. (This is drawn with the growing end downwards, and the structure is perhaps shown better in consequence.)

Fig. 3.—Transverse section of ditto, × 25.

Fig. 4.—Portion of same, magnified fifty times.

Fig. 5.—Operculum of *Myriozoum subgracile* d'Orb., × 85.

Fig. 6.—Operculum of Cellepora (Fig. 8), × 85.

Fig. 7.—Surface of *Heteropora pelliculata*; *b*, portion with the thin covering removed.

Fig. 8.—Cellepora from Australia.

Fig. 9.—*Heteropora cervicornis* d'Orb.

Fig. 10.—Surface of ditto.

Fig. 11.—Ditto, with covering removed.

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* 'Mém de la Soc. Géol. de France,' ser. 2me, vol. v. pl. xi. The name *H. pustulosa* was employed by Haime five years previous to the publication of the 'Crag Polyzoa,' and therefore the same name given by Mr. Busk as a new species will require to be changed. Haime's specific name *pustulosa* had been employed by Michelin and d'Orbigny for his species, though the generic name they used was Ceriopora.

Mr. Busk explains by considering the septa to represent the remains of hymen-like lids, which have been left behind at successive stages of growth. I have not found this to be the case in this species or fossil ones examined, but suppose it must occur in other species.

The pore-tubes can be seen in the transverse sections, Figs. 3 and 4; in Fig. 4, they are shown passing through the zooecial walls; this structure is the same as we find in all Cyclostomata, and the inner portion of Fig. 4 would represent equally well Idmonea, Hornera, &c., for in all of this sub-order numerous minute pores occur in the walls, as is also shown in the longitudinal section, Fig. 2, which may also be considered as a characteristic section of the shell structure of the group. In the Cheilostomata, on the other hand, numerous perforations are exceptional, but in the cell-walls of most are comparatively large disks, called rosette-plates, having one or numerous apparent perforations. In *H. pelliculata* the interior of the zooecial tubes has delicate longitudinal markings, with occasional faint transverse lines of growth (see Fig. 2).

The external surface can best be studied with a calcined fragment. In a piece thus prepared, the calcareous base of a thin pellicle is seen to cover nearly all the surface. The zooecial apertures are nearly equidistant and have sometimes a thin cover, as is the case with most of the Cyclostomata; * surrounding each cell are about eight cancelli, covered, as already pointed out, and in these coverings are several perforations round which the white calcareous film is thicker, thus giving the appearance of raised warts, and, in fact, until the organic matter is removed this structure cannot be correctly appreciated. The openings of the cancelli are usually much smaller than the zooecial apertures, though in some cases they are nearly as large.

I have been unable to identify it with any fossil form, and therefore call it

Heteropora pelliculata, nov.

Zooarium erect, branches cylindrical, frequently dividing dichotomously, ends of branches sometimes taper, at others swelling out into a subglobular termination. Zooecia; parallel tubes, perforated with minute depressed pores. Zooecial orifices circular, interstitial orifices subcircular, disposed round the zooecial orifices. Surface covered with a thin calcareous and organic pellicle, cover of cancelli numerously perforated.

Hab.—The Gulf of Tartary and the neighbourhood of the island of Saghalien and Japan, between the latitudes 41°–46° N.,

* Such covers of the Cyclostomatous Bryozoa are specially worthy of note, for in Polypora and other Carboniferous fossils belonging to the Fenestellidæ similar closures have been pointed out by Mr. John Young.

and longitudes 141°–143° E., in from fourteen to thirty-seven fathoms.*

The next instance of the occurrence of Heteropora is interesting, as being found under somewhat parallel circumstances.

In the Australian seas there is a Cellepora, probably common, as I have seen it in several collections. It grows round the stalks of seaweeds, &c., and is raised into ridges irregularly encircling the zoarium (Fig. 8), with zooecia on each face of the ridge, so that it may be said to have in part a biserial growth, and this is known in Mesenteripora, Reticulipora, Eschara, Flustra, Biflustra, &c.

I have not been able yet † to identify it with any described species, and in my own collection distinguish it as *C. repleta* (thus in part retaining the meaning of the generic name Plethopora).

It is not, however, with this we have now to deal, but with a Bryozoon (Fig. 9) of quite similar mode of growth, found in a small boxful of the Celleporæ, just mentioned, which my sister picked up on the Semaphore near Adelaide; however, as soon as it is put under the Microscope, it is seen to be a Cyclostomatous Bryozoon, and I do not at present see any reason for placing it in any other genus than Heteropora.

The zooecial apertures (Fig. 10) are more irregularly placed than in the last species, in which the region of the aperture was only slightly raised; but here it is elevated in a tubular form, and the walls of the cancelli are also elevated. The perforations of the cancelli covers are larger, with the white rim round each hole very distinct. Where this film is removed (Fig. 11) there are spinous protuberances round the aperture.

This is apparently the *Plethopora cervicornis* d'Orb., 'Pal. Fr.,' pl. 799, figs. 4, 5, found in the Sénonien, and which is placed by him among the Cyclostomatous forms, but until I discovered this recent one I had always supposed the figure represented a worn specimen of Cellepora, similar to the one already mentioned.

Heteropora cervicornis d'Orb.

Plethopora cervicornis d'Orb., 'Pal. Fr.,' vol. v. p. 1045, pl. 799, figs. 4, 5.

Zoarium incrusting stalk of seaweed, raised into irregular ridges. Zooecial aperture crateriform; cancelli, mostly one series round the zooecium, covers perforated with few large holes.

* There are from the same locality stems of varying sizes, some not more than half the diameter figured, but whether they are all the same species I cannot say with certainty. If the material had been my own, I should have chipped fragments off all and made detail examination, but this could hardly be allowed in a national collection, and I have to thank the Museum authorities for allowing me to make sections of a broken fragment.

† I take this opportunity of saying I hope shortly to carefully study the Australian recent and tertiary Bryozoa, and shall be glad of any assistance that naturalists can give me.

Hab.—Chalk. Environs de Tours (d'Orb.). Recent. Adelaide.

The genus Heteropora has been found in the Jurassic of England and France, and the external appearance of *H. lepida* Novak.,* is much the same as that of the recent species. The genus was also frequent in the Maestricht chalk. *Heteropora dichotoma* and two other species are mentioned by Reuss and Manzoni, from the Miocene of Austria and Hungary. Busk mentions several species from the Crag, and the American tertiaries have also yielded it, but it does not appear to have been previously found recent.

Besides the interest of the genus occurring recent, the striking similarity in shape of *H. pelliculata* and *cervicornis* to Cheilostomata taken in the same hauls is a most curious fact.

* "Beit. z. Kennt. der Bry. der böhm. Kreid.," 'Denk. k. k. Ak. Wissensch. Wien,' 1877, vol. xxxvii.

XXV.—*Note on Homogeneous Immersion Object-glasses.* By F. H. Wenham, F.R.M.S.

(*Read* 14*th May*, 1879.)

As the homogeneous immersion object-glass is revived as a recent idea, I quote from a paper contributed by me to the 'Monthly Microscopical Journal,' June 1st, 1870, the following comment in favour of homogeneous immersion. "One advantage in the immersion objective is, that it almost prevents the loss of light from the reflection of the upper surface of the cover and front of lens, and in part neutralizes any error of figure and polish that may exist between them. There is also another condition annexed; it has the singular property of *a front lens of adjustable thickness*, and therefore can be set to the utmost nicety to balance the aberrations. Of course there is no optical advantage attendant upon the use of *water*. If a medium of the same refractive power as the glass were to be employed, the result would be better. Water having a low refractive index, an adjustment is required for each thickness of cover, and a difference of adjustment is not so marked and sensitive as in the ordinary dry objectives; but if a medium of similar refraction to the glass were to be used, no adjustment would be required for any thickness of cover, supposing the test objects to be mounted thereon (which they generally are); for, in fact, we should then view them all with a front of the same thickness—considering the cover, the front lens, and the interposing medium as one." *

[Since the above was read, Mr. Wenham has sent us the following additional note on this subject.—Ed. 'J.R.M.S.']

In the 'Quarterly Journal of Microscopical Science,' No. 11, 1855, p. 303, I described as part of the system of an object-glass, a front lens connected with the slide by an intermedium of Canada balsam; of this I say, "It will be seen from the position of the object, that each ray of light passing from that point through the surface of the hemisphere, will be transmitted in straight lines in a radial direction without undergoing any refraction; the consequence of which is, that the full and undiminished aperture of the object-glass is made to bear upon the object." Of the actual performance obtained by this object-glass (a $\frac{1}{8}$), I say on the next page: "When an object is seen under these circumstances, it at once shows the great increase of distinctness that is to be obtained in the structure of the more difficult Diatomaceous tests when they are thus viewed in Canada balsam with the full aperture of the object-glass. Markings which in the neighbouring dry objects of the same character are scarcely discernible, are sharply and distinctly visible under the balsam hemisphere, with the same illumination."

* The discussion on this Note will be found at p. 494.

NOTES AND MEMORANDA.

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Primitive Stripe in the Chick.—The so-called primitive stripe, or groove, had a future ascribed to it by the earlier embryologists, which the more modern authors regard as belonging to a different set of embryonic structures: to the elucidation of this question, Dr. Mathias Duval has lately * devoted himself. Messrs. Foster and Balfour, in their 'Elements of Embryology,' remark that "by the earlier observers the primitive groove was supposed to become converted into the medullary canal. Dursy ('Der Primitivstreif des Hühnchens') was the first to give a correct account of its disappearance; and the distinction between it and the medullary groove has since been fully recognized by many observers." In addition to information which confirms this view of Dursy's, M. Duval describes the characters of the adjoining regions.

Bearing in mind the difficulty as to the exact stage at which an embryo may be found to have arrived, a difficulty which is not lessened but rather increased by information as to the exact length of the incubation period, M. Duval has not contented himself with merely stating the number of hours. Imagine two embryos found at exactly the same stage of development, but that one has been seventeen and the other twenty-one hours in incubation. It is obvious that the ready method, ordinarily adopted, of regarding the one as being some stages behind the other, would easily lead to a belief in the succession of certain changes, such as that which was asserted to obtain with regard to the primitive groove. Another method of examination had therefore to be adopted. Having obtained a series of blastoderms, of which he had registered the length of the incubation period, M. Duval examined them by surface view, and chose them out by pairs; of each pair one remained intact and easily adapted to inspection, while the other was hardened and stained,—and cut into sections; these sections, again, were not registered as being cut from an embryo of a definite age, but from one (A, B, and so on) of which he had a corresponding and intact example.

The developmental period which was studied, was found to be divisible into three groups; one was from the fourteenth to the twenty-second hour of incubation; the second from the twenty-second to the thirty-second; and the third from the thirty-second to the fiftieth hour.

In the first period, inspection reveals the presence of an embryonic "spot," which may be divided into two regions; to the more anterior and smaller part the name of *tergal zone* is given, while the rest forms the *primitive line*, and, later on, the *primitive groove;* the zone grows but little during this period; in it the epiblast is alone well defined

* 'Ann. Sci. Nat. (Zool.),' vii. (1878) Nos. 5–6.

the remaining parts forming merely a series of irregular masses of small spheres, in which, in fact, the processes of segmentation are being still carried on.

The history of the primitive line during this period is altogether different; not only does it increase in size three or four times, but it presents an altogether distinct hypoblast-layer, while the epiblast is seen to be connected with cells, which will ultimately form the mesoblast; at the fourteenth hour the primitive line is simple and homogeneous, and it is with difficulty that a faint depression can be observed; at the nineteenth hour the pit of the fourteenth has become a long groove. Running along this line or groove there may be observed a delicate filament, for which the name of *epiaxial filament* is now proposed; for this structure Dursy had proposed the name of *axial*, and his observations are quoted and corrected in some details, the correct apprehension of which the French embryologist ascribes to the use of osmic acid.

In the second period the primitive groove undergoes no changes of any importance, but in the tergal zone certain modifications obtain, which lead to the formation of the medullary groove and of the dorsal cord; these changes commence with the great increase in size of this region; the cells of the mesoblast extend outwards towards the sides of the embryo, and also form a condensed mass at the level of the bottom of the medullary groove; this mass is the future chorda dorsalis. Much of what happens in this period, as in the succeeding one, could only be rendered intelligible by the aid of a number of figures.

Of the third period, the most important characters are the continuation of the metamorphoses of the tergal zone, and the retrograde development of the primitive groove; the author refers to what he has already stated as to the fourth ventricle of the brain, and the so-called rhomboidal sinus, and insists on the fact that the medullary groove is completely closed along its whole extent, so that the two regions just mentioned owe their origin to modifications of the central canal of this part.

Dr. Duval concludes his paper with three statements; the first, in which he definitely states that the primitive groove ought to be absolutely distinguished from the medullary groove, and that these parts have different periods of, and different regions for, their development, is accompanied by a detailed criticism of the works and statements of earlier embryologists; in the second, he deals with the history of the three layers of the embryo, and shows that the course of development of these three is different in the tergal zone to what it is in the parts posterior to it; and he brings this to bear on the statements of Remak, Waldeyer, Goette, Balfour, and Durante, who assert that the mesoblast is developed from the hypoblast; of Kölliker, who ascribes to the former of these two layers a purely ectodermal origin; and of His, who would regard the epiblast and hypoblast as both being the seat of origin of the mesoblast.

The third statement is that the chorda dorsalis is solely formed from the tergal zone and in front of the primitive groove, and that it is formed from the hypoblast, or at any rate has the same origin as

the mesoblast, with which layer its earlier stages of development are most intimately bound up.

Evolution of the Male and Female Genital Glands of Mammalia.—M. Ch. Rouget gives * a short account of his work on this subject, from which there is so much still to be learnt that is of great importance in any comprehensive or correct account of the structure and relations of the group.

So soon as the common rudiment of the genital glands gives rise to those peritoneal cells which invest the genital layer, and these cells thicken (twelfth day in the rabbit), a number of cylindrical cells with large nuclei are found among them (primordial ovules); gradually they pass inwards and become connected with the so-called *segmental cords*, in which they form lines, the separate elements of which are separated from one another by masses of small cells. The first sign of sexual differentiation is the disappearance of the ovules of the epithelial layer, and the formation of the earliest rudiments of the *tunica albuginea*. From the sixteenth to the twentieth day the number of ovules increases rapidly, and that the more in the male; the primitive cells, with an ovoid nucleus, form a reticulum for the ovules in the female, and seem to be the rudiments of the flattened cells of the primordial follicles. In the cortical portion there are small cells, which increase very rapidly in the male; the ovules persist even during infancy in the male glands, and appear to form the large cells, to which La Valette St. George has given the name of *spermatogonia*. The important point, then, that the ovules are essential elements of the testicle, which was first shown by Balbiani to be true of the Plagiostomous Fishes (and more recently of a young sheep), may be fairly extended to all mammals at any rate, as M. Rouget has observed them in the human embryo, in rabbits, cats, and dogs.

Natural Science Prizes of the Brussels Academy.—The subjects for the Natural Science prizes of the Brussels Academy for 1880 are the following:—

1st. (A geological subject.)

2nd. "Explain the history of the germinative vesicle in ova capable of developing by parthenogenesis." The author to choose the object of his essay amongst the different species of animals in which parthenogenetic development has been positively established.

3rd. "New observations are required on the relations of the pollen-tube with the ovule in one or more phanerogams."

The value of the medals to be awarded are 800 francs each, and the essays must be written in French, Flemish, or Latin.

Cells and Nuclei.—Dr. Klein continues, in the 'Quarterly Journal of Microscopical Science,' † his observations on the structure of cells and nuclei, forming Part II., and dealing with the epithelial and gland-cells of mammals. This was written before the appearance of Professor W. Flemming's article on the same subject in the 'Archiv

* 'Comptes Rendus,' lxxxviii. (1879) 602.
† 'Q. Journ. Micr. Sci.,' xix. (1879) 125.

f. Mikr. Anatomie,' * which is referred to by Dr. Klein in a postscript, in which he points out that Flemming's views on the structure of cells and nuclei and the relation of the two do not in some respects coincide with those already expressed by himself. In the third and concluding part of his observations, he proposes to discuss in detail these differences.

B. INVERTEBRATA.

Invertebrates of Kerguelen's Land.—Professor Studer gives some account † of the results of his stay in this island, the fauna of which appears to offer some very interesting peculiarities; four new species of *Cladocera* are described and figured, one of the *Ostracoda*, and two *Copepods;* some remarks are made on the anatomy of *Brada mammillata* Grube, which, it is concluded, belongs to the *Pheruseidæ* of Grube, although it differs from them in the want of tentacles and branchiæ; its coiled enteric canal, the gastric cæcum, and the white excretory glands are all points of resemblance; the animal is distinguished by the presence of tubercular skin-glands, which form a secretion by which particles of sand are united together to form a closely fitting investment for the animal. A new species of the interesting Chætopod genus *Ophryotrocha* is also described (the specific name proposed is *Claparedii*); the two segments next to the head carry no appendages, and are merely provided with a circlet of cilia; the next following all carry lateral foot-stumps; the labrum was simple and toothless, while the lower jaws carried seven projecting tooth-like ridges; the cephalic lobes have only one band of cilia; this latter is of especial interest, as being an organ which has not been lost, as it has been in most annelids, during the passage of the creature from its larval to its adult state; the condition of maturity was indicated by the presence of ova.

In a later contribution,‡ Studer gives a list, with bibliographical and other remarks, of all the animals known to live in Kerguelen's Land and the surrounding sea.

Mollusca.

Blood-cells of the Acephala.—The cells of the blood of *Unio* are ordinarily found to be amœboid in character, and provided with a large number of sharply-pointed pseudopodia; the plasma is colourless and not highly refractive; they vary in size in various Lamellibranchs within comparatively wide limits; they are generally provided with a single nucleus, which is small as compared with the size of the cell, and is granular; a number will be observed to contain fatty matter. The most striking point, however, is their tendency to develop long processes, while under observation, and with these pseudopodia they may manage to unite themselves into masses of a considerable size. To the question as to how far this was a natural occurrence, Flemming has addressed himself.§ A drop taken by the aid of a pipette from a

* See this Journal, ii. 137.
† 'Arch. f. Naturgeschichte,' xliv. (1878) 102.
‡ Ibid., xlv. (1879) 104.
§ 'Archiv f. Mikr. Anat.,' xv. (1878) 243.

fresh pulsating heart did not present any blood-cells with processes of any great length, but in about a minute observation revealed their presence; the same results were obtained with blood taken from the vessels, and the conclusion is arrived at that in the circulating blood the cells only give off a few and those short processes; it is obvious that the presence of large conglomerate masses would effectually stop up the smaller blood-vessels, and it is observed that it is rare for such masses to be observed in fresh blood.

At times a few immobile bodies without processes, and of a smaller size, were also observed; these might be rounded or formless, and present or not present distinct nuclei.

Later Stages in the Development of Fresh-water Mussels.—M. Blanchard gives * an account of Max Braun's observations.† These were rendered successful by cutting up the gills of a female Anodon, and so separating the embryos therein contained, and placing them in an aquarium in which were a number of fish; on these Vertebrates the embryos soon fixed themselves and attained their adult stage in something over seventy days. Having fixed themselves by their byssus-threads, the so-called *Glochidia* fasten their shells into the fins or other parts of their hosts; the inflammation so started gives rise to a proliferation of epithelial cells, in which the larvæ are soon encysted. As may be imagined, observations on their development were thus rendered easy, and Braun is able to state that the byssus-gland soon disappears, that the single adductor muscle of the valves, having become double, soon makes way for other organs, while the permanent adductors become developed; the foot appears at first as a cone situated in the middle of the larva, and the pedal ganglia become evident; the median portion of the enteric tube gives rise to two hepatic cæca; the mantle of the embryo, which consists of large cylindrical cells, disappears, and the new mantle, which is made up of small cubical cells, takes its place. This absorption is accompanied by that of the bony ray of the fin to which the embryo had become attached, and the calcareous salts from it appear to go to form the shell of the adult. The generative organs are not developed till later, and when the young is set free from the cyst.

Locomotion of the Terrestrial Gasteropoda.—Heinrich Simroth has an interesting article on this subject,‡ which is one on which little has been done of late, and the views of Bergmann and Leuckart are still accepted by most zoologists. According to these observers the mechanism of locomotion in the common garden snail is essentially the same as in a number of apodal insect-larvæ, with this exception, that the number of waves which pass over the body are much more numerous, and the attachment of the foot to the surface moved over is more complete. There is, of course, no doubt that locomotion is effected by the waves which pass over the foot from behind forwards,

* 'Rev. Internat. des Sci.,' ii. (1878) 634.
† 'Verh. Phys.-Med. Gesellsch. Würzburg,' xiii.; SB., p. xxiv. (4th May, 1878).
‡ 'Zeitsch. f. wiss. Zool.,' xxx. Suppl. (1878) 166.

and that it is more rapid in proportion as these succeed one another more rapidly; but these waves do not seem to be locomotive when the animal is placed on a glass, as it was in Bergmann and Leuckart's experiments, and the only change which then occurs is in the coloration of the organ. So long as the animal is at rest, the foot is all of the same colour, but when it begins to crawl the transverse bands become darker (*Helix*, *Arion*), or of an ashy hue (*Limax*). In *Helix* the waves pass over the whole of the foot anteriorly, and over the great part of it posteriorly; in *Limax* and *Arion* they are limited to the median third.

Some three hundred experiments of the following character were made:—A snail was made to crawl up a glass cylinder and the following points were observed:—(1) The length of the animal; (2) the length of the passage; (3) the number of waves in an equal period of time; (4) how often a wave passed during the experimental period; (5) the length of the period; (6) the weight of the body; and (7) the weight of the foot. Calculations based on these observations lead to the conclusion that "the smaller animals have the greater power of locomotion, and that this law does not apply merely to the smaller genera and species, but also to the smaller and younger individuals of the same species." It is, however, to be noted that in *Helix pomatia* and *H. hortensis* the waves succeed one another less rapidly in the smaller than in the larger examples; and it is concluded that the most successful number of undulations are those of from 30 to 40 centimetres in length. It follows from other measurements that the body moves more rapidly up to a certain point, and that after this an increase in the number of waves is of less use, while it is shown that the smaller number of undulations in smaller animals is, within the limits of this law, of greater physiological value than the higher number observed in the larger forms. The next law stated is now easily comprehensible—the physiological value of the individual waves is inversely proportional to the number of waves which pass over the foot in a given period. From experiments in which the animals had a weight to carry, it is found that within limits they are able easily to do so, inasmuch as the unloaded snails are not able to make use of all their activity.

The voluntary muscles of the *Gasteropoda* are those in the dermo-muscular tubes, and those derived therefrom (m. columellaris, and muscles of the tentacles); in formation these seem to be intermediate between the smooth and the striped elements found in the *Vertebrata;* these are the *retractile* muscles, by which the different parts of the body are brought into relation; while the *protrusile* muscles, or those by which locomotion is effected, are the longitudinal muscular fibres of the foot. In *Helix* these extend over the whole of the breadth of that organ with the exception of a small marginal portion; in *Arion* and *Limax*, as might be supposed from what has been already stated, they are confined to the median third. In addition to these there are other fibres which run in various directions, and there is a special layer around the pedal gland, and above it there is a covering of transverse muscular fibres; in the upper half of the hinder portion there is a

longitudinal layer connected with the columella, and of function in withdrawing the animal into its shell.

The retractile bundles are chiefly innervated by the pedal ganglia, which are, moreover, the chief centre for the locomotor muscles also; these pass in two parallel rows into the foot, and are given off to the muscles by pairs, and at regular distances from one another. When a motor nerve is stimulated the muscle-serum becomes less capable of dissolving myosin, and the consequent coagulation, which is always associated with extension of the protrusile muscle, causes a change in the characters of the light reflected from the foot; with each stimulation this coagulated spot varies in position according as different nerve-branches are excited, and this coagulation extends from behind forwards. For further details the paper, which is a very valuable contribution to this branch of physiology, must be consulted; but we may point out that Herr Simroth observes that the difference noted between the living protrusile and retractile fibres is evident also in the dead animal, the former being elongated, and the latter greatly contracted.

Auditory Organs of the Heteropoda.—Professor Claus opposes* the views of Professor Ranke on three points: (1) According to this latter observer there are only four auditory cells, in addition to the large central cell; Claus thinks that there are a large number. (2) The structures regarded by Ranke as ganglionic are the concentrically arranged auditory cells in the thickened sensory epithelium, into which the fibres of the auditory nerve pass. (3) There is not a single plate in the relatively large cavity between the central cell and the outer auditory cells, but four large indifferent supporting cells. It is of course impossible to make the differences plain without reproducing the figures, and we must be content with drawing attention to the subject.

Peculiarity in Littorina.—In a paper "On some Australian Littorinidæ" † the Rev. J. E. Tennison-Woods says that there is one peculiarity in some members of this genus to which attention has not been drawn by any naturalist, and it is so very common and so peculiar that it must have some relation to the animal economy. It consists of a spiral white or yellow line or groove, which lines the interior of the shell and arises from the anterior aperture, or at the lower part of the labrum or outer lip. Along the groove the organs of reproduction are always exserted whether they be male or female. It is not easy to explain why this portion of the shell is differently coloured, unless it is in keeping with what is noticed in the colouring of certain flowers, butterflies, &c. The whole of the *Littorinæ* have the aperture of dark colour though highly enamelled, and this whitish line is a conspicuous diversity in the appearance, though it would be a very narrow view of the operations of nature to say that its only purpose was to attract.

The author also establishes that the Australian Littorinidæ so

* 'Arch. f. Mikr. Anat.,' xxv. (1878) 341.
† 'Proc. Linn. Soc. N.S.W.,' iii. 55.

closely resemble the European genus *Littorina*, that they cannot be generically separated from it; that the genus *Risella* should be suppressed as no permanent generic character can be defined in it; that *Tectaria pyramidalis* is merely Littorina with a double line of granules, and that all the Australian species have the groove or line above mentioned, which is in some way connected with the organs of reproduction.

Structure and Physiology of the Octopus.—An extended series of observations made on this animal at Roscoff are published by the Royal Academy of Belgium.* Attention has been already drawn in this journal (pp. 164–166) to the new substance which M. Fredericq has found in the blood and to the action of the chromatophores; we may now add an account of the vascular, excretory, and other systems.

Circulatory Organs.—Examined under water, and after the removal of a small portion of the ventral wall of the mantle and of the visceral sac, the rhythm of the heart is easily observed; the contraction commences in the peritoneal vessels and vena cava, and passes onwards to the "venous hearts" at the base of the branchiæ, thence to the auricles, and thence to the arterial ventricle or heart proper. About thirty-five pulsations can be counted per minute, and as each takes about $\frac{1}{33}$ of a minute the contractions overlap more or less. The action of this organ is not affected by the removal of the periœsophageal ganglion, the section of the pallial nerves, or the extirpation of the pallial ganglia, and this evidence on the one hand, as well as the fact that different parts removed from the organism, or the whole heart removed from water, still continue to beat for a time, point to the presence of exciting centres in the cardiac region itself. The contact of the air, mechanical, and still more electrical excitation, accelerate the action of the heart, on which also certain nerves from the œsophageal collar seem to have an accelerating or a depressing action; the former run along the great vena cava, and the moderator fibres are found in the trunks of the visceral nerves, as was first shown by Paul Bert.

The latter seem to resemble very closely the pneumogastric nerves of the *Vertebrata*, inasmuch as section of them increases the number of pulsations, while weak excitation diminishes them, and strong excitation brings the heart to a standstill in diastole.

But rhythmical contractility is not confined to the heart and its neighbouring vessels; the veins, even in their furthest ramifications, present the same character, as may be well seen by examining an *Octopus* into which a little colouring matter has been introduced; two large veins may then be seen in any one of the arms, which anastomose largely with a number of smaller subcutaneous venous ramules; along their whole length a wave of contraction may be seen to pass, which, though apparently irregular for the whole, is quite regular and rhythmical in any given portion; these beats are altogether independent of the central nervous system.

The pressure of the blood in the arteries appears to be very great,

* 'Bull. Acad. Roy. Belg.,' xlvi. (1878) 710.

as it is shown to be equal to 8 centimetres of mercury, whereas in *Testudo* it is only from 30 to 50 mm., and only 70 mm. in *Coluber natrix*.

The lacunæ so common in the vascular system of other Mollusca are here replaced by capillaries, and there does not seem to be in the *Cephalopoda* any means by which the sea-water is enabled to mix itself with the blood.

Excretory Organs.—The *Octopus* is provided with peritoneal cæca, which contain a clear, and at times viscid, liquid, which holds in suspension a number of brownish granular bodies, crystals of carbonate of calcium, epitholial cells (and parasites, the most interesting of which is the curious *Dicyema typus* of Van Beneden). There is no reason for supposing that these structures belong to an aquiferous system, as their orifices are ordinarily closed, and the contained liquid is a secretion from the glandular appendages of the veins, and is of the nature of an effete body. M. Fredericq has been unable to find the uric acid which Harless and Bert had found in *Sepia*, but he has discovered in its place the presence of guanine, and he gives, as we need not do, the method by which he proceeded.

Respiratory System.—To deal with the nerves by which the alternate opening and closing of the muscular mantle around the respiratory cavity is effected: all these are given off from the sub-œsophageal ganglionic mass, as may be shown experimentally by first removing the whole of the head, when the respiratory movements cease altogether, and then removing the supra-œsophageal ganglia, when they are in nowise affected. These movements appear to be reflex, as the author states that the pallial nerves also supply the integument of the mantle, and that section completely destroys all sensibility in these parts. Excitation of the peripheral end of the pallial nerve or direct irritation of the pallial ganglia produces energetic contractions, while excitation of the central end of the nerve gives rise to symptoms of distress. Section of the visceral nerves ordinarily arrested the respiratory movements immediately, but excitation of the central end, if sufficiently strong, produced a temporary reaction; this excitation seems to pass to the sub-œsophageal mass, and thence by the pallial nerves; the former or visceral set seem, among other things, to give sensibility to the branchiæ, and the constancy of the respiratory movements seems to depend largely, if not entirely, on their integrity; these movements then are reflex, whereas M. Fredericq, like most modern physiologists, regards the action in the Mammalia as *automatic*. The question now arises, how does the respiratory centre, if there is one, of the Cephalopoda act under the irritation of alterations in the characters of its air-supply? The answer is very remarkable: interruption of the cephalic circulation diminishes and slows the respiratory movements, a stay in poorly aerated water has the same effect, and a return to water from air is not accompanied by an increase, but by a decrease in the number of the respiratory movements.

Digestive Organs.—The contents of the intestine, the secretion of the salivary glands and of the liver, are distinctly acid; the aqueous infusion of the fresh salivary gland has no action on starch,

whereas that of the liver converts it into glucose, and, in an acid solution, digests fibrin; this latter organ contains no traces of bile acids or pigments, and yet M. Fredericq is unwilling to propose any alteration in its name.

Nervous and Muscular Systems.—M. Fredericq is of opinion that the supra-œsophageal ganglia are the seat of psychical processes and ought to be compared to the cerebral hemisphere of the *Vertebrata;* he states that the sub-œsophageal masses contain the centres for the respiratory movements, the chromatic function, and for the movements of the various muscles of the body; he comes to the same conclusion as Colesanti as to the physiological similarity of a single arm and a decapitated frog; there are in it no true voluntary movements, but the reflex ones are manifested much more energetically.

In chemical composition the muscles seem to resemble those of the *Vertebrata;* the aqueous extract contains an enormous quantity of taurine, and the so-called *idio-muscular contraction* can be very easily caused to appear in the muscles of the mantle.

Neomenia and the other Amphineura.—Dr. Jhering gives* an abstract of the work lately done on this subject, and does good service in pointing out that the name *Solenopus* Sars was published without any description, and that therefore it cannot take the place of Tullberg's name—*Neomenia.* The heart is found to have a similar position—median and dorsal—to that of the same organ in Chiton, but the view that *Neomenia* is hermaphrodite does not find acceptance with Jhering. The observations of Graff on the nervous system appear to point to the natural character of the group *Amphineura*, in the opinion of its founder, who takes occasion to point out that Mr. Dall's palæontological researches confirm his views of the phylogenetic relations of the *Patellidæ* with the *Tecturidæ.* It may be of interest to note that Koren states that he has known this remarkable *Neomenia* for the last thirty years.

Anatomy of Chiton.—H. von Jhering describes † the results of his own observations on some points in the structure of these eminently interesting Mollusca, and gives a critical revision of the statements of previous authorities. Looked at from his point of view, as, indeed, from any, the importance of these forms cannot be overestimated; our author regards the Chitons as intermediate between the Mollusca proper and the Annelides, and is of opinion that their developmental history is much more similar to that of the just-mentioned *Vermes* than to that of the *Gasteropoda.* It is, indeed, only of late years that these forms have found their proper place in the zoological system; Latreille, in 1820, placed them with the *Trilobites*, and de Blainville, in 1825, with the *Cirripedia.* The observation of Herr Jhering was chiefly turned to the generative and renal organs and the histological characters of the muscular system, during his late stay at the Zoological Station at Trieste; these are his conclusions:—

1. The Chitonidæ are diœcious.
2. The ovarian eggs are enclosed in a follicle; in *C. squamosus* this secretes a spiny chorion.

* 'Morphol. Jahrbuch,' iv. (1878) 147. † Ibid. 128.

3. The ova are fertilized in the ovary.

4. The kidney is a ramified gland, placed at the base of the cœlom, and invested by a ciliated epithelium; it gives off a median and unpaired efferent duct, which opens below the anus.

5. The secreting vesicles of the renal organ are developed in the nucleus of the kidney-cells, and not, as in most Mollusca, in the protoplasm of these elementary parts.

6. The muscular fibres form fibrillar bundles, which are enclosed in a nucleated sarcolemma.

7. These fibrillæ are simple in the pedal muscles, but in those which form the buccal mass there is an anisotropic substance which forms sarcous elements, and these are separated from one another by isotropic substance. The separate fibrillæ do not correspond to one another, so that the "striation" which has been observed in the same region in the *Gasteropoda* cannot be said to exist here.

It is of interest to observe that M. Jhering states that there are striped or unstriped fibrillæ in the adductor muscles of the Anodonta, the portion which *is* striped appearing to be that which effects the rapid closure of the shell.

The paper is illustrated by a plate of sixteen figures.

Phenomena which precede the Segmentation of the Ovum in Helix aspersa.—M. Perez thus describes these phenomena in a paper to the Bordeaux Society: *—The ovarian ova meet, in the diverticulum, the spermatozoids which fecundate them. The germinal spot, at first clear and homogeneous, assumes a cloudy aspect, and two small nucleoli become vaguely visible. Later on, the spot becomes pale and diffluent and the germinal vesicle disappears.

Around the freed nucleoli a radial system is formed of the fusiform body and the two suns (soleils) known to embryologists. The two nucleoli enlarge, and soon acquire a vesicular envelope. It is not long before they are divested of the radial system which they had formed by the contractions of the vitelline mass, which pushes outwards (under the form of polar globules) the radial substance, which is more fluid than the vitellus.

But the two cellular bodies thus enucleated remain in the vitellus, where they are shown with the utmost ease by reagents in the place formerly occupied by the germinal vesicle. They rapidly increase in size as they approach the centre of the vitellus; and at the same time their nucleus decomposes into a great number of nucleoles of unequal size. Then one of them is completely destroyed. The other, undergoing very nearly the same fate as the germinal vesicle, disappears, leaving as its only trace two of the nucleoli which it enclosed. These, becoming free by the destruction of the cell-wall, give rise to a new radial system similar to the first, which becomes the "point de départ" of the segmentation.

Liver and Digestion of the Cephalopodous Mollusca. — From experiments made by M. Jousset de Bellesme on the liquid secreted by the liver of *Octopus vulgaris*, obtained by cutting a perispherical

* 'Rev. Internat. Sci.,' iii. (1879) 280.

portion of the gland and hollowing out in it a cavity, in which the liquid accumulated, he arrives at the conclusion * that the gland called *liver* among the Cephalopods has no functional analogies with the liver of Vertebrates. It is a digestive gland, destined to transform the albuminoid matters *alone*, which these animals make their usual food, and is without action on the fatty and amylaceous matters. He pointed out the same fact some years ago in *Carcinus mænas* and *Astacus fluviatilis*, and since then M. Plateau has arrived at the same results in his researches on the Arachnida and Myriapoda, so that it may now be considered to be established that the liver of the higher Vertebrata is not represented in the Invertebrata.

The communication of M. Jousset de Bellesme confirms in some respects the researches of Krukenberg on the same subject,† and those of Fredericq.‡ The infusion of the hepatic tissue (of the Poulp), Fredericq says, digests fibrine both in acid and in alkaline solutions, and transforms starch into glucose. Therefore we have here a diastatic ferment, and another ferment acting on the albuminoids which is neither pepsine nor thrypsine (it is a mixture of both, according to Krukenberg), and he reiterates what he previously said of the liver of the slug: § "The so-called liver of the Poulp is a digestive gland, which could be better compared with the pancreas of the Vertebrata." The opinion of M. Jousset de Bellesme differs from the preceding in that he rejects the idea of any action of the liver of the Poulp on amylaceous and fatty matters.‖

In regard to digestion, M. Jousset de Bellesme (in a subsequently published note ¶) says that the superior salivary glands of the Poulp do not exercise any digestive action; their liquid only serves in mastication and deglutition. As for the inferior salivary glands, their function would be to dissolve the connective tissue without attacking the muscular fibres themselves; whilst the liquid of the liver, on the contrary, digests the albuminoid matters. The author adds: "After numerous attempts, operating sometimes on fasting animals, sometimes on animals which were digesting, I became convinced that none of the liquids supplied by the glandular appendages are capable of emulsionating fats and transforming starch into glucose. We therefore have to do with an animal which only possesses the power of digesting albuminoid and connective matters, and the fact is all the more remarkable as some of its own organs, the liver, for instance, contain a large proportion of fatty matters." This would be a convincing argument in favour of the opinion that living beings may form fatty matters by the disassimilation of albuminoid matters; but M. Fredericq shows that the liver of the Poulp transforms starch, and emulsionates fatty substances.**

* 'Comptes Rendus,' lxxxviii. (1879) p. 304.

† "Versuche zur vergleichenden Physiologie der Verdauung," in 'Unters. aus dem Physiol. Instit. der Univers. Heidelberg,' i. (1878) 327.

‡ 'Bull. Acad. Sci. Belgique,' xlvi. (1878) 761. § Ibid. 213.

‖ 'Rev. Internat. Sci.,' iii. (1879) 263.

¶ 'Comptes Rendus,' lxxxviii. (1879) 428.

** 'Rev. Internat. Sci.,' iii. (1879) 271.

Molluscoida.

New Tunicata.—Professor Heller, in continuation of his previous papers on the Tunicate fauna of the Adriatic and Mediterranean, now describes* a number of new species from the Atlantic and Indian Oceans, from the South Sea, and the Antilles; these, of which there are thirty, belong to the following genera:—*Ascidia* (6), *Rhodosoma* (1), *Cynthia* (6), *Microcosmus* (5), *Polycarpa* (8), *Styela* (3), and *Boltenia* (1). He owes his opportunities to the kindness of Professors Schmarda and Möbius, and to the director of the Museum Godeffroy at Hamburg.

He appears to have been especially struck by the extraordinary similarity of the forms from these very different regions; not only do all the species belong to known genera, representatives of which are to be found in the European seas, but many of the species examined were absolutely identical with such. Thus, *Ciona intestinalis* was brought from Sydney, as was also the *Styela grossa*, which is not rare at Trieste, while *Cynthia dura*, another Adriatic form, was collected in the Antilles and off New Zealand. The *Microcosmus claudicans*, so common in all European seas, was found in the whole extent of the Indian Ocean and of the South Seas, while it does not appear to be absent from the West Indian region; and the same remark applies to *Polycarpa pomaria* and *P. varians.* The paper is illustrated by six plates of thirty-two figures.

Arthropoda.

Gall-making Aphides.—The life-history and agamic multiplication of the Aphididæ have always excited the interest of entomologists, and have even attracted the attention of some of the most eminent of our naturalists. With all their vast numbers and their universality, their life-history has, however, baffled the skill of many an observer, and this has been especially the case in the gall-making forms which so disfigure our trees. Researches carried on into the life of the Phylloxera have, however, somewhat cleared the way, and Dr. Riley begins, vol. v. for 1879, of the 'Bulletin of the United States Geological Survey' with some biological notes, in which he recounts the following most remarkable history: It will be remembered that destructive as these insects are, they are most fragile, and languish in confinement, so to trace out all their daily history for a space of over ten months was a labour requiring diligence and perseverance—one that probably would not have been successful had not Dr. Riley been helped by an enthusiastic lady friend. The first species studied is known as *Schizoneura americana.* It infests the leaves of the American elm, sometimes in such numbers as to cause all the leaves to fall. If during the winter the cracks in the bark of an American elm that was badly infested with this leaf-curling species the previous summer be examined, there will pretty surely be found here and there a small dull yellow coloured egg, about ·5 mm. long, probably still covered with the remains of the female's body, quite dried up. Out from this egg will in the early spring be hatched the little crawling creature

* 'SB. Akad. Wien.,' lxxvii. (1878) 83.

which constitutes the first generation in a very remarkable series, settling upon the tender opening leaves. This "stem-mother" begins to feed, causing the leaf to swell up and pucker until it at last curls over the tiny form. After three moults, and the temperature being warm, it commences to people the leaf with young at the rate of about one every six or seven hours. The second generation, though they never grow to be at all as large as the stem-mother, are like her in many respects. They accumulate in vast numbers, some of which, scattering, form new colonies. Their issue forms the third generation which are destined to become winged. These winged forms are short-lived, but they lay twelve or more pseudova at average intervals of about half an hour. The young plant-lice from these form the fourth generation, the members of which are very active, running swiftly. They are of a brown colour, and are somewhat like in general appearance to those of the second generation. In this stage they swarm over every portion of the tree, and their necessities cause them to migrate, in which effort masses of them get destroyed. The fifth generation is very similar to the fourth. It gives rise to forms like the fourth, but without wings. These give origin to the sixth generation. All of these acquire wings. These abound in the latter end of June and early part of July. They congregate on the bark, seeking out sheltered cracks or crevices, in which they deposit their young. These form the seventh generation, and are sluggish, of the colour of the bark, the females a little larger than the males. They have no mouth. They live for several days without motion. The female seems to increase in size by the enlargement of her one single egg. Both sexes soon perish, leaving among their shrivelled bodies the shining, brownish, winter egg with which we started; so, after a long series of vegetative reproductions, at last the time comes for the renewing of the race by this zygospore-like body. Surely in this lies a hint to our plant-growers. It would be easier to destroy a single egg than stop a stream of agamic-produced forms extending to six generations.*

Buzzing of Insects.—In a supplementary communication on this subject (see vol. i. pp. 276 and 373), M. Perez says that he does not agree with M. de Bellesme in thinking that a conical movement (mouvement conique) of the thorax can produce a sound, because, on fixing the animal with a pin, the movements are very attenuated, without the movements of the wings and the buzzing being destroyed or even weakened. These movements cannot therefore explain the buzzing.†

Larval Cases of Phryganeidæ.—Several new forms of *Phryganeidæ*, exhibiting interesting modifications of the larval cases, have been discovered in Brazil by Fritz Müller, who describes them in a letter to his brother Hermann Müller.‡ He says, "I have lately found several new larvæ of *Phryganeidæ*. The group of *Hydroptilidæ* seem particularly rich in this place in peculiarly shaped larva-cases. Hagen

* 'Times,' 12th March, 1879.
† 'Rev. Internat. Sci.,' iii. (1879) 281.
‡ 'Zool. Anzeiger,' ii. (1879) 38.

only knew of four of these cases. I have already found nine, which must be classed under six quite distinct genera:—

I. Cases resembling mussel-shells, with narrow slit-like anterior and posterior apertures (as *Hydroptila*). They are carried on the sharp edge. (They look particularly like mussels when they are formed of rod-shaped diatoms, which then represent as it were the lines of growth.)

1. Upper and under edges parallel, almost straight; coated outside with fine sand. Larvæ with three caudal tracheal gills.

2. Of a similar shape but made of algæ or diatoms. Larvæ without gills.

3. The dorsal angle strongly arched; the case made without the aid of foreign materials.

II. Case formed of diatoms, the sides pressed together, with a narrow anterior and posterior slit; the edge of the back has two funnels (I call them for the present *Dicaminus*). For entering the pupa stage they are fixed upright, and sometimes whole villages of these cases are found attached to stones. The use of the funnels is evident, viz. to give free entrance to the water necessary for respiration. The larvæ in the small mussel-like cases which have no such tubes, are seen to make, almost continuously, brisk serpentine movements in their cases with the posterior part of their body—with the result of introducing fresh water. The *Dicaminus* larva never does this.

III. Almost cylindrical, coated externally with fine sand. Diminutive tubes, only 2 mm. long and about ·5 mm. in diameter.

IV. Cases attached to movable stalks.

V. Scutiform cases, fastened all round, similar to an egg-case of *Nephelis*, with a small hole at each end.

VI. Flask-shaped cases (*Lagenopsyche* nov. gen.). These are especially remarkable. In distinction to almost all the known cases of *Hydroptilidæ*, the anterior and posterior ends of which are equally and uniformly made use of for the larvæ to creep both in and out of, the cases of the *Lagenopsyche* differ greatly at the two ends, the anterior opening being round, and the posterior a long narrow slit. All the other *Phryganeidæ* look out of the last formed and wide part of their tubes; *Lagenopsyche* out of the first formed neck of the flask. I know no other instance of the change in position of the pupa in its case (what for it is front, above, and below, for the larva was behind, right, and left). The imago usually creeps out in the first hour or two of the afternoon."

Development of the Silkworm.—A preliminary account of his researches on this subject is published, by A. Tichomiroff,* whose chief results are as follows:—

1. The author was able to confirm Bobretsky's observation as to the passage of amœboid cells from the interior to the periphery of the egg, in order to form the blastoderm. This process was best seen on the second day after the eggs were laid. There was no evidence to show whether these amœboid cells originated, according to Bobret-

* 'Zool. Anzeiger,' ii. (1879) 64.

sky's hypothesis, from the egg-nucleus, but it seemed probable that they were formed freely in the interior of the egg after fecundation; in sections of the new-laid egg, small lumps of protoplasm were found, the appearance of which convinced the author that in them the future amœboid germ-cells were to be sought.

2. Tichomiroff differs from former workers at the embryology of insects, in denying the formation of the muscular layer by an invagination of the ectoderm. He states that a temporary sinking in of the outer layer takes place in the position of the future dorsal groove, but that he has never observed a true invagination. The cells of the muscular layer are formed by division from those of the ectoderm, the process taking place at any point in the germ-lamella, and not only in the middle.

The yolk-spheres, with their numerous nuclei, which are seen in all stages of development up to hatching, are true formative cells, at the cost of which the mesoderm grows. They also give rise to migratory cells, the latter being not unfrequently found in the interior of the yolk-cells.

4. To the endoderm, i. e. the epithelium of the midgut, the author assigns a very remarkable origin. When the mesoderm has undergone segmentation, it undergoes complete solution of continuity along the middle line of the germinal streak, so that two distinct mesodermal plates are formed, as in Worms and in some Vertebrates. These mesoderm plates then begin to grow towards the dorsal side of the embryo, forming a pair of lamellæ, which soon separate from the rest of the mesoderm as midgut-plates (Mitteldarmlamellen), and then grow ventralwards as well as dorsalwards. At the same time their most superficial layer of cells become so differentiated as to form the flattened epithelium of the future midgut: the remaining cells become the thin muscular layer. The two midgut-lamellæ then begin to approach each other both dorsally and ventrally: ventrally they soon unite, and so close in the gut below; dorsally, on the other hand, they remain separate for a long time, and undergo an extraordinary change in their mode of growth. Their outer or muscular layer, in fact, begins to grow faster than the inner or epithelial layer, and soon extends beyond the latter, so that now each midgut-lamella consists of two parts—a ventral two-layered plate, united with its fellow below, and a dorsal purely muscular band. The two muscular bands thus differentiated from the midgut lamellæ grow upwards, diverging somewhat from one another, until they are in close contact with the dorsal wall of the embryo, when they curve inwards towards one another and unite completely. In this manner a double tube is produced, having, in cross section, the form of the figure 8. Of the two tubes, which are at first in free communication with one another, the ventral one, composed of an outer muscular, and an inner epithelial layer, becomes the midgut: the dorsal tube, wholly muscular, becomes the dorsal vessel of the insect's blood-system.

5. The silk glands take their origin simultaneously with the tracheæ, and in their earlier stages resemble the latter completely.

6. There are no cephalic tracheæ, the invaginations of the ecto-

derm which take place in the head being the foundations of the internal cephalic skeleton. The latter consists, firstly, of a hollow rod bridging over the occipital foramen, and, secondly, of the chitinous bands which stretch from the foramen to the angle of the clypeus. These bands are hollow, and in the region of the brain are dilated into a vesicle which communicates with the exterior by a tolerably wide aperture.

7. There is a true lower lip which must be looked upon as the serial homologue of the labrum.

8. The thin inner egg-membrane, lying beneath the chorion, is quite evident even in the youngest stages, before the formation of the blastoderm.

9. The cells of amniotic epithelium often send out processes which meet and fuse with the cells of the epiblast, and so form strongish bands connecting the epiblast with the amnion.

10. The tergum of the embryo is formed by a gradual narrowing of the root of the amnion, as a result of which process the cells of the tergal epiderm long resemble the flat amniotic cells.

11. Large cells become separated off from the epiderm, and remain unchanged to the end of the embryonic development, even existing in the young larvæ as lateral cell-aggregations (Zellencomplexe).

12. In the epidermis itself very large nucleated cells are found among the ordinary small cells: probably these have some relation to the development of hairs.

Venomous Caterpillars.—Mr. E. D. Jones, C.E., Corr. Memb. of the Literary and Philosophical Society of Liverpool, relates, in the Proceedings of the Society,* an experiment he made with a caterpillar in Brazil, on 28th February, 1878. The species is not given, but it is described (with a plate) as 1½ inch long, very thick in proportion to its length, and the whole body covered with long red-brown hairs, which grow in tufts arising from the centre of each segment, and at the base of the long hairs are bunches of venomous spines which are quite concealed by the hairs. The body is very soft and fleshy, and of a paler colour than the hairs. The head is very small, and is when eating quite covered with a fleshy mantle formed by the first segments of the body.

Feeling certain it was an exceedingly venomous caterpillar, he determined to sting himself with it.

At 11 A.M. he applied the back of the caterpillar to the back of his left hand, with sufficient pressure to feel the pricking of the spines. In ten minutes he had violent pain in the hand, and the place of contact had swelled up into a white lump surrounded by a dark-red inflamed patch. A few minutes later, violent pain set in under the armpit. At 11.30 a red rash appeared on the inside of the elbow, and this gradually extended up to the shoulder, along the biceps, and down the arm to the place of injection on the hand. The rash was slight, excepting just at the elbow. Soon after 12 there was a sensible weakness of the hand and arm, either an effect of the extreme pain or a distinct effect of the poison. At 12.15 the rash

* xxxii. (1878) p. cii.

began to disappear, and the pain under the arm sensibly diminished. The affected area on the hand began to perspire considerably, and the pain in the injected spot was as violent as ever, burning horribly like a scald. At 1 the armpit pain had nearly ceased, the rash had disappeared, but the pain in the hand was so bad that he could hardly bear it. Boring a hole with a red-hot iron came nearest to the effect in his imagination. At 5, 6, 8.30, and 10, there was diminished pain, though at 1.30 A.M. he awoke with it. Next day it was gone, but the soreness not until the day after. The marks of the points of the thirty-six spines were still visible when he wrote (16th March).

Abortion of the Hairs on the Legs of certain Caddis-flies, &c.—Mr. C. Darwin, writing to 'Nature,' says* that several of the facts given in the following letter from Fritz Müller, appear to him very interesting. Many persons have felt much perplexed about the steps or means by which structures rendered useless under changed conditions of life, at first become reduced, and finally quite disappear. A more striking case of such disappearance has never been published. Several years ago some valuable letters on this subject by Mr. Romanes (together with one by himself) were inserted in the columns of 'Nature.' Since then various facts have often led him to speculate on the existence of some inherent tendency in every part of every organism to be gradually reduced and to disappear, unless in some manner prevented. But beyond this vague speculation he could never clearly see his way. As far, therefore, as he can judge, the explanation suggested by Fritz Müller well deserves the careful consideration of all those who are interested on such points, and may prove of widely extended application. Hardly anyone who has considered such cases as those of the stripes which occasionally appear on the legs and even bodies of horses and apes—or of the development of certain muscles in man which are not proper to him, but are common in the Quadrumana—or again, of some peloric flowers—will doubt that characters lost for an almost endless number of generations, may suddenly reappear. In the case of natural species we are so much accustomed to apply the term reversion or atavism to the reappearance of a lost part, that we are liable to forget that its disappearance may be equally due to this same cause.

In the letter (written from Brazil), Fritz Müller says that there is there a locality in which a peculiar fauna lives, viz. the rocks of waterfalls, which are of very frequent occurrence. On these rocks, along which the water is slowly trickling down, or which are continually wetted by the spray of the waterfall, there live various beetles not to be met with anywhere else, larvæ of diptera and caddis-flies.

The pupæ of these caddis-flies, as well as those living in Bromeliæ, are distinguished by a very interesting feature. In other caddis-flies the feet of the second pair of legs (and in some species those of the first pair also) are fringed in the pupæ with long hairs, which serve the pupa, after leaving its case, to swim to the surface of the water for its final transformation. Now neither on the surface of bare or moss-covered rocks, nor in the narrow space between the

* 'Nature,' xix. (1879) 462.

leaves of Bromeliæ, the pupæ have any necessity, nor would even be able, to swim, and in the four species living in such localities which he examined, and which belong to as many different families, the feet of the pupæ are quite hairless, or nearly so, while in allied species of the same families or even genera (*Helicopsyche*) the fringes of the legs, used for swimming, are well developed.

This abortion of the useless fringes is of considerable interest, because it cannot be considered, as in many other cases, as a direct consequence of disuse; for at the time when the pupæ leave their cases and when the fringes of their feet are proving either useful or useless, these fringes, as well as the whole skin of the pupa, ready to be shed, have no connection whatever with the body of the insect; it is therefore impossible that the circumstance of the fringes being used or not for swimming, should have any influence on their being developed or not developed in the descendants of these insects. As far as he can see, the fringes, though useless, would do no harm to the species, in which they have disappeared, and the material saved by their not being developed appears to be quite insignificant, so that natural selection can hardly have come into play in this case. The fringes might disappear casually in some individuals; but, without selection, this casual variation would have no chance to prevail. There must be some constant cause leading to this rapid abortion of the fringes on the feet of the pupæ in all those species in which they have become useless, and he thinks this may be atavism. For caddis-flies, no doubt, are descended from ancestors which did not live in the water, and the pupæ of which had no fringes on their feet. Thus there may even now exist in all caddis-flies an ancestral tendency to the production of hairless feet in the pupæ, which tendency in the common species is victoriously counteracted by natural selection, for any pupa, unable to swim, would be mercilessly drowned. But as soon as swimming is not required and the fringes consequently become useless, this ancestral tendency, not counterbalanced by natural selection, will prevail, and lead to the abortion of the fringes.

Comparative Embryology of the Insecta.—Professor Graber in a preliminary article * gives a brief history of the results of his observations, which appear to be of considerable importance. An examination of the ovarian cell at an early period has revealed the presence, in the centre of the yolk, of a number of amœboid cells, which appear to have been formed by the division of the germinal vesicle; these "primary embryonic cells" have a relatively large nucleus and a number of nucleoli; several may be seen to unite with one another by means of their pseudopodia, and they may also be observed to undergo division. The blastosphere always consists of a single cell-layer, and always undergoes "emboly"; its first differentiation is into two layers only, or, in other words, there is no independent appearance of the mesoderm, which in these forms at any rate always owes its origin to the endoderm (endoblast). The internal germinal cells arise in two ways, some independently of the

* 'Arch. f. Mikr. Anat.,' xv. (1878) 630.

blastoderm, and others from the endoderm; this is well shown in the diagram.

Germinal vesicle

Germinal cells

Outer germinal cells (blastoderm) — Inner germinal cells (primary)

Outer germinal cells (blastoderm): Ectoderm — Endoderm (endoblast)

Endoderm (endoblast): Mesoderm — Inner germinal cells (secondary)

The inner germinal cells, which evidently correspond to the migratory cells of earlier embryologists, may not be observed till a very late stage in development; similar bodies have been seen in the spiders, where they appear to represent the germ of the enteric gland (liver-germ), which is only distinctly differentiated after the embryonic stage is passed.

Investing Elements.—In all the insects examined by Graber, the blastoderm was seen to develop an investing segment, and also to give rise to a cuticle, so that at a certain stage nine layers may be made out in the embryo:—

(1) Tertiary investment of the ovum. Remains of the epithelium of the ovarian follicle.
(2) Chorion. Secondary investment. Cuticle of ovarian follicle.
(3) Vitelline membrane. Primary investment of the ovum. Cuticle of the yolk.
(4) Cuticular investment of the germ. Cuticle of (5)
(5) External cellular germ-membrane
(6) Internal " "
(7) Ectoderm
(8) Mesoderm
(9) Endoderm

(7)–(9): Embryo

(4)–(9): Derivates of the Blastoderm.

In some insects (*Butterflies*, *Carabus*) cavities may be observed between the layers numbered 3 and 4, and between the inner germ-membrane and the peripheral yolk, and these are filled with a substance different to, but developed from, the ordinary yolk.

Tracheal System of Glomeris.—In the first of a series of papers on the morphology and anatomy of the *Julidæ*,* Dr. Ernst Voges, of Göttingen, describes the arrangement of the tracheæ in the genus *Glomeris*.

The stigmata, which are situated, in pairs, immediately in front of the attachments of the legs, have a biscuit-shaped aperture, with tumid edges, produced into numerous spiniform prolongations, which form a sort of grating over the aperture.

* 'Zool. Anzeiger,' i. (1878) 361.

Each stigma leads into a backwardly directed tube, which soon divides into two branches. Of these, the inner and smaller is directed forwards, and passes immediately into a trachea: while the outer and larger passes obliquely outwards, backwards, and upwards, and becomes continuous, in like manner, with a large trachea.

The tubes which put the tracheæ in communication with the stigmata differ from the stigmatic pouches of *Julus*, in that the latter are directed forwards from the external aperture. The tubes are probably metamorphosed portions of tracheal stems.

Structure of the Hydrachnida.—Croneberg gives* a brief account of his observations, which were originally published in Russian. In all species which he has examined he has found a chitinous framework internal to the labium, which consists of two pieces which bend forwards and unite above the mouth; these form a chitinous groove which is connected with a system of muscles, all of which go to make up a powerful suctorial apparatus. Above the mouth there are two other chitinous ridges, which enclose the commencement of the two primary trunks of the tracheal system.

The œsophagus passes through the ganglion and then widens out into a large stomach; it is provided with a number of cæcal sacs, which vary in number from five to thirty-four; these are all connected together and are invested by an epithelium, which consists of large brown cells, and represents the liver. The fatty body seems to be represented by a layer of smaller and more transparent cells, covering the stomach and the excretory organs. These latter, in all cases, end by a portion which passes directly to the anus, which persists even where the rectum is absent, and the midgut ends blindly.

The buccal glands are arranged in three groups, of which two are racemose and one tubular; they all three have a common duct. The generative glands vary greatly in character and position; in *Eylais* they consist of a system of communicating longitudinal and transverse canals, which form a network around the stomach; there is a single orifice. In *Nesœa* and *Hydrachna* the ovaries are circular in form, but the testes consist of five large pyriform tubes united at their base (*Nesœa*), or of a number of smaller and pedunculated saccules. In all three cases the seminal duct passes into a muscular bulb, and the oviducts into a wide, muscular vagina.

Acarina found parasitic in the Cellular Tissue and Air-sacs of Birds.—To the general rule that the superficial or cutaneous parasites of animals—the so-called Epizoa—belong to the group of the *Articulata*, and that the internal parasites are *worms*, there are, as might be expected, some not inconsiderable exceptions; thus there are *Filariæ* which infest the skin, and there are insects (*Œstrida*) to be found in the stomach of the horse, the pharynx of the deer, and in the cranial sinuses of the sheep. M. Megnin, in writing on this subject,† makes but brief reference to the *Linguatulidæ*, but these Arachnoids, as they are ordinarily considered, may be referred to in a little more detail as

* 'Zool. Anzeiger,' i. (1878) 316.
† 'Journ. Anat. et Phys.' (Robin), xv. (1879) 123.

indicating the slight value which can be attached to such broad generalizations as that just stated.

Ludwig Graff, in his work on *Myzostoma* (Leipzig, 1877) proposes to unite that form with the Linguatulida and Tardigrada into a group, intermediate between Arthropods and Vermes, for which he suggests the name *Stelechopoda*. So much on the one hand: on the other, a larval *Pentastomum* (the most important, if not the only genus among Linguatulids) has been found in the human liver, and others in that of the hare and like forms, while the nostrils of dogs and the lungs of the boa are also well-known homes for these curious forms. In the paper now to be examined, descriptions are given of several species of Acari, which have been found in the more internal organs and tissues of birds; the first to describe any of these forms was the Italian zoologist Géné, who, in 1845, gave an account of a form which infested every specimen of *Strix flammea* found in the neighbourhood of Turin; the number found in the tissue underlying the skin appears to have been enormous, but no lesions could be discovered by which they might have entered; the skin, curiously enough, retained its natural colour, and the superjacent feathers exhibited no alteration of form or colour. To this form Géné gave the name *Sarcoptes strigis*, and he compared it with the form, *S. nidulans*, described by Nitzsch; this comparison was not very full, but this again is hardly a matter for astonishment, as it has since been shown that Nitzsch's form was not a *Sarcoptes* at all. The parasite on the Turin *Strix* is described as being only $\frac{1}{10}$ of a line in length, of a pearly white, with the body convex superiorly, and flattened inferiorly.

In 1866 another form was described by Mr. Robertson, of the University Museum, Oxford, who discovered it in the pigeons which were provided for the instruction of the students of that Institution; this was said to be visible to the naked eye, white and vermiform; its chief abode was the subcutaneous connective tissue around the great veins of the neck, and the region of the pericardium. A critical study has shown that Robertson's form was described by Filippo de Filippi in the year 1861, under the name of *Hypodectes nycticoracis;* in 1872 M. Slosarski, of the University of Warsaw, examined the parasite of the pigeon, and, while giving a new name, confirmed the statements of the Oxford anatomist as to the absence of distinct internal organs, and of the large quantity of granular vesicular sarcode which filled its interior.

The observations of M. Megnin himself were commenced at the instigation of M. Alph. Milne-Edwards, in the same year (1872), and the bird examined was *Lophyrus coronatus*. Here the forms described by Robertson and Slosarski and by Professor Géné appear to have been found together. As it is impossible to give a detailed account of his observations, we will deal with the more interesting of the two; this was not half the size of the other, the mouth was much more rudimentary, the integument smooth and diaphanous, and no trace of an anus was evident; this curious form can only be explained by reference to the life-history of the *Acarina*, in which there are a succession of stages, which are nothing less than

veritable metamorphoses; when the larva is on the point of passing to its second stage, it becomes altogether inert, all the internal organs become resolved into a semi-fluid substance, which envelops a kind of *blastodermic membrane*, which behaves exactly as the blastoderm of the eggs, and gives rise to swellings which develop into new appendages, and which are themselves arranged just as are the appendages of the developing larva; soon casting its envelope, a new and larger Acarus appears, but the rejected envelope exhibits all the former organs of the larva, empty and discoloured; this curious rejuvenescence may be effected in the space of twenty-four hours.

In the normal course these changes, the essential characters of which are the same in all moults, pass through the following cycle: ovum, larva, normal nymph, sterile female, ovigerous female. When the course is altered in any way, the form in most cases dies down at once, but there are certain species which escape, thanks to a method to which M. Megnin, its discoverer, has given the name of *adventitious metamorphosis*.

This is what occurs with *Pterolichus falciger*, a form which infests pigeons; when the pigeon moults with great rapidity, and loses nearly all its feathers, the normal nymph, instead of becoming a male or sterile female, gives rise to a worm-like form, and passes to the cellular or peritracheal tissue, which is especially loose in these birds; here it lives for a time and increases in size, passing again towards the integumentary tissue only when the ordinary conditions of its existence are re-established. It was apparently forms in this stage which fell under the observation of Messrs. Robertson and Filippi.

After a description of acarine parasites of the gallinaceous birds, M. Megnin gives an account of the form found in the air-cavities; this specimen does not appear to belong to the *Sarcoptidæ*, but to be the representative of a new group, of which it is at present the only known genus; M. Megnin finds that it is provided with a conical rostrum, which is perforated anteriorly, and which is formed by the fusion of the maxillæ, the labial palps, and the mandibles; he names it, on account of its mode of life, *Cytoleichus* (κυτός = cavity, and λείχω = lick up); living as it does on the walls of the cavities which it inhabits, it does not seem capable of producing any inflammation of these parts. The species has, on account of its form, the name *Sarcoptoides*; it is described as ovoviparous, and an account is given of its male, young female, nymphs, octopod and hexapod larvæ. The form is found in the air-sacs of the *Gallinæ*, and especially of the *Phasianidæ*, where it lives in colonies; the individuals are of a relatively large size, and of a white colour. It is only dangerous in excess, when it may produce cough, and, perhaps, asphyxia.

On some Genera of Acarina.—Haller's two papers on this subject* are reviewed by Megnin;† the first is a revision of the genus *Analges* (*Dermaleichus*). It may be interesting to note the earliest observations

* 'Zeitsch. f. wiss. Zool.' (1877).
† 'Journ. Anat. et Phys.' (Robin), xiv. (1878) 107.

on these forms, which were made by Redi (1728), C. C. Cuno (1734), de Geer (1783), and Hermann (1809); as at present regarded, there are two (subgeneric) sets of forms in the genus *Analges;* in one (*Chelopii*) the third pair of limbs are of great size, and provided with a tubercular process to the second joint, which takes part in the formation of a strong pincer; in the second group (*Pachycnemici*) this tubercle is absent, although the appendages in question are of an enormous size. Haller recognizes four species in the former, and nine in the latter group; but Megnin looks upon three of these latter, one of which is a new species (*Certhiæ*), as all belonging to one species, while the two new species of Haller (*affinis* and *coleopteroides*) are regarded as belonging to the *A. corvinus* of Robin and Megnin.

In his second paper Haller describes two new genera of avicolous mites—*Freyana* (dedicated to Professor Frey) and *Picobia;* the former Megnin is inclined to regard as a sub-genus of *Pterolichus;* the second, which was found under the integument of *Picus canus*, appears to be allied to *Myobia*, although it has, according to Megnin, affinities to the parasitic *Chyletidæ*.

Parasitic Chyletidæ.—M. Megnin makes * some very interesting remarks on parasitism, in which he founds a new division of these forms; as is well known, Van Beneden has pointed out the differences between their habits of life, and has grouped them as (1) Commensal, (2) Mutual, (3) Parasitic; on these there is no need to insist, but the new class to which the name of *auxiliary parasites* is given must be briefly described. The author one day chanced to enclose with some *Listrophora*, which belong to the second group, two *Chyletidæ*, which, although of about the same size, are very much more active; these he observed to set on the *Listrophora*, to kill them, and suck their juices. These, then, are truly auxiliary parasites; truly so it should be said, inasmuch as the African "beef-eaters" which extract the larvæ of the *Œstridæ* from the back of oxen, buffaloes, and gazelles, or the falcons of South America, which perform a similar service for the llamas, do not live solely on the parasites of these animals.

A word is said as to the views of Van Beneden on parasites proper. This author states that "the presence of several tæniæ in the human intestines constitutes 'un état de santé enviable,'" but it is pointed out that various Ungulata and even Carnivora can and do fall a prey to these parasites; and it is therefore proposed to divide the forms into an inoffensive and a dangerous (pathogenic) group.

A number of forms are described in detail and figured, and some remarks made on their physiology, of which the following are the more important points:—

Differences in Form.—On a superficial view these are very striking, but the differences exhibited are only to be observed in those structures which come into relation with the host.

Digestive Apparatus.—The mouth is essentially a conical sucker, formed by the fusion of the labrum and maxillæ; the enteric tube is straight, and is but rarely provided with cæca; the anus is very

* 'Journ. Anat. et Phys.' (Robin), xiv. (1878) 416.

small. In *Harpirhynchus* this latter is absent, owing, apparently, to the mode of life of this animal, which feeds itself on the product of the sebaceous glands of its host, and gets rid of the effete gases by means of its tracheal system.

Respiratory Organs.—The tracheæ are very well developed, and are made up of two principal trunks which open near the rostrum. The stigmata have a screw-shaped form, thanks to which the entrance of foreign bodies is very effectually prevented.

Generative Organs.—The male organ is always placed behind the anus, where this is apparent, and the female organs occupy the same position in two species; curious as this fact appears to be, we must remember that in the *Hirudinea* and even *Annelides* the position of the genital orifice may vary very greatly.

Organs of Relation.—The appendages differ in even different species, owing to the different modes by which the possessors are connected with their hosts; in the genus *Chyletus* these variations are confined to the terminal portion of the appendages; in *Harpirhynchus* the hinder ones are greatly reduced, and in *Myobia* they are very delicate.

Intimate Structure of the Central Nervous System of Decapodous Crustacea.—M. E. Yung describes * the nervous system of the Crustacea as composed of fibres and cells. The fibres always present an envelope and contents. Contrary to the opinion of Remak, fibrillar bundles are never found homologous with the cylinder-axis of the nerves of Vertebrates. The fibrillar structure does not appear until after the action of reagents. The contents of the cells are also surrounded with an envelope, and are in all points similar to those of the tubes. There is a nucleus (sometimes two) enclosing one or more nucleoles, which contain in their turn nucleolules. The cells are apolar, monopolar, and bipolar. They are rarely found with three prolongations. With reagents they behave in the same way as the fibres. The latter are, in fact, nothing but cellular prolongations. The elements grouped in the commissures and the ganglia are surrounded with a double envelope of connective tissue. The brain seems to be formed of three pairs of ganglia.

Functions of the Ganglionic Chain in the Decapodous Crustacea.—In a note in a late number of the 'Comptes Rendus,' † M. Yung says that the functions of the ganglionary nervous system of the Arthropoda are still little known. He has studied them in the higher Crustacea (lobsters, crabs, &c.), always making use of living animals, and having regard, in the interpretation of the results, to the influence of the operation, and the circumstances under which it has taken place. There are a number of causes of error in these experiments which explain the divergences of opinion amongst previous authors, and which are to be avoided by operating not upon one only but upon many animals.

* 'Comptes Rendus,' lxxxviii. (1879) 240; 'Rev. Internat. Sci.,' iii. 160.
† 'Comptes Rendus,' lxxxviii. (1879) 347.

The following are the results of M. Yung's observations:—

The ganglionic masses and the commissures which unite them are evidently sensitive throughout the chain; the sensibility is the same on the superior, inferior, and lateral faces.

The roots of the nerves radiating from the chain are both motor and sensitive, contrary to the classical opinion of Newport, Valentin, Longet, &c.

Each ganglion is a centre of sensibility and of motion to the segment of the body to which it belongs; but the sensibility becomes "*inconsciente*" and the movements reflex when the ganglion is separated from those which precede it.

The sub-œsophageal ganglion is the motor and sensitive centre for all the masticatory elements and the foot-jaws.

The brain or supra-œsophageal ganglion is sensitive on all its faces, contrary to what prevails among insects, whose brain, according to M. Faivre, is insensitive. It plays the part of motor and sensitive centre for the cephalic appendages (eyes, antennæ).

Each right and left side of the brain acts upon the corresponding part of the body, and it is the same with the other ganglia of the chain. There is no interlacing in the course of the nervous fibres.

The removal of the brain causes the toppling movement forwards, which arises from a want of equilibrium, resulting from the insensibility of the cephalic appendages, and from the predominance of the movements of the posterior members.

The movements which continue after the total removal of the brain, and which in certain cases have a character of spontaneity, are never co-ordinated.

The lesion of one of the lobes of the brain produces "mouvements de manége" from the injured side towards the other.

The brain is the seat of the will and of the co-ordination of movement. It has no direct action on the movements of the heart.

The movements of the heart are accelerated by electrical excitation directed to the commissures of the œsophageal ring, whence the current travels to the stomato-gastric ganglion and the cardiac nerve (the nerve described by Lemoine). They are retarded by the electrical excitation of the thoracic ganglia.

Male Organs of the Decapodous Crustacea.—The new Zoological Station at Trieste is already bearing good fruit, an example of which is to be found in the long and elaborate paper on this subject, * illustrated by six plates, by Dr. C. Grobben. The state of science during a long period is well illustrated by the fact that no one seems to have taken any interest in the subject to which Dr. Grobben directs attention, between the time of Aristotle and 1750, about which time Portius and Von Rosenhof examined the male organs of the crayfish.

A. *Internal Organs.*

I. Position. In the *Thoracostraca* the testes are always placed superiorly to the intestine, and in all, except the *Paguridæ*, between this organ and the heart; in the *Stomapoda* they are placed in the

* 'Arb it. Zool. Inst. Wien-Triest,' i. (1878) 57.

abdomen; in the *Schizopoda* and *Macrura* in the thorax; in the *Galatheidæ* they extend in front of the digestive stomach, and in most *Brachyura* they reach to the very anterior portion of the branchial cavity; the efferent ducts ordinarily open at the coxa of the last pair of thoracic feet.

II. Structure. In all *Decapoda*, with the exception of the *Paguridæ*, the testes consist of paired parts and an unpaired piece; they are generally divided into anterior and posterior lobes, but the unpaired portion varies greatly in position; in *Astacus* it is represented by the unpaired hinder lobes, but as a rule it forms one, and in some cases two. connecting pieces set transversely.

These organs are simplest in structure in *Squilla mantis*, where they form a tube, the walls of which bulge out into inconsiderable cæca, which are invested by a sperm-producing epithelium; in *Athanas*, among the *Decapoda*, the testes are merely elongated sacs, but the spermigenous epithelium invests regions only of their walls. As the sac elongates, the germinal region becomes broken up, and the testicular tubes attain to an acinous character; this is seen e. g. in *Palæmon*, and further stages of complication are observed in *Alpheus*, in *Astacus*, and in *Homarus*. The testes and efferent ducts are always invested by connective tissue, which varies a good deal in character: in *Homarus* it is very well, but in *Astacus* it is very feebly developed. In various forms, striated muscular fibres were observed in the walls of the testes, the presence of which is explained by the fact that one-half or two-thirds of the testicular tubes here form merely efferent ducts.

Two sets of elements are distinguished in the germinal elements; the one set forms large cells with a large rounded nucleus—spermatoblasts; the other forms a protoplasmic mass in which no cells can be made out, but merely a number of nuclei interposed between the bases of the spermatoblasts; these nuclei, which vary greatly in form, stain very readily; these are the reparative germs, so called because they appear to take the place of the effete spermatoblasts; the difference in these two sets of elements is not to be observed in the young, in which indeed the reparative germs alone appear to be present in any quantity, and what difference there is finally, is shown to be no greater than what obtains in the case of the ovarian cells and the cells of the ovarian follicles; just as each follicular cell is potentially an ovarian cell, so the reparative germs are potentially spermatoblasts; these latter are formed by the metamorphosis of the reparative germs, just as the ovarian cells are formed from those of the follicle. These considerations support the doctrine of the homology of the testis and ovary, as do also the presence of reserve matters in the spermatoblasts, and the striking similarity of the structure of these two organs in such forms as *Eupagurus* (P. Mayer).

III. Structure and development of the seminal corpuscles. As is well known, these bodies are markedly distinguished by their "radiate form," but it is pointed out that the equally common belief in their motionless character has certain exceptions; the simplest arrangement is found in *Squilla*, in which too their history is most easily followed out; an elaborate examination leads to the conclusion

that in the *Macrura* these bodies are larger than in the *Brachyura*, and within the limits of any group the spermatozoa seem to be proportional in size to the general size of the body; greatly as they vary in size, they vary in form still more, and the dictum of Wagner that the Vertebrate spermatozoa may even vary in various species, may be completely applied to the *Decapoda*, and the influence of this variation on the preservation of species is insisted upon, inasmuch as it is obvious that the more the spermatozoa vary in character, the less will they be able to set up the molecular changes by which fertilization commences, in the females of other species than their own; and further, those species are most likely to be preserved that have highly differentiated spermatozoa.

The sum of the rays appears to be homologous with the flagellum of the Vertebrate spermatozoon, and it is pointed out that immobile spermatozoa are never found in any animal in which chitinous structures are not developed.

IV. Vasa deferentia. The author distinguishes in these three chief regions: (1) An efferent portion, which is delicate; (2) a broader glandular portion, and (3) a *ductus ejaculatorius*, which is ordinarily provided with a very powerful musculature. This duct may give rise to lateral dilatations of various sizes, which seem to provide a menstruum for the sperm. Their presence has been frequently denied.

V. Spermatophores. All the *Decapoda* examined by the author form spermatophores, the envelope for which is ordinarily formed in the vas deferens; in *Astacus*, this envelope is of a dead-white colour, which hardens in the water, while the envelope of *Homarus* swells up under the same conditions. In form these spermatophores vary greatly: they are bluntly conical in *Scyllarus*, stalked in *Eupagurus*, pouch-shaped in *Porcellana;* in other *Brachyura* there is no special form for the different members of the group, and in *Dromia* there can hardly be said to be a spermatophore at all.

B. *External Generative Characters.*—As is well known, there is an easily recognized difference between the male and female; of the accessory generative characters by which this is effected, some are due to the development of other organs, such as the ovary, and may be shown to owe their origin to natural selection; others are due to the development of parts which have for their purpose the safety of the sperm or of the young, and these have a similar origin; others, again, are due to sexual selection, such as the offensive organs formed by the appendages of the males, or their coloration; while the last set of all are dependent on the different modes of life of the two sexes.

C. A few brief observations are made on the vascular supply of the generative organs, in which the antennary and sternal arteries take a large share: a species of *Distomum* was observed in the vas deferens of *Portunus depurator*.

Central Nervous System of the Crayfish.—In a brief communication,* consisting of histological and of morphological observations, Krieger states that the *perineurium* consists of a firm membrane, in

* 'Zool. Anzeiger,' i. (1878) 340.

which a number of interlaced bands and elongated connective-tissue nuclei can be made out. The name perineurium is applied to the general investment of the nervous system, while that of *neurilemma* is applied only to the coverings of the separate nerve-fibres. The tissue ordinarily known as the outer neurilemma is stated to belong to the connective tissue of the body cavity. As to the nervous elements, he agrees generally with Dietl, but he finds a number of nucleoli in the nuclei of the large ganglion-cells, and also notes that the "tubular" nerve-fibres do not appear to be formed of primitive fibrillæ, but to be composed of a strong sheath containing a clear viscid fluid.

The dotted substance of Leydig is found to be composed of a number of distinct spheres, which are arranged in pairs, which, again, are ordinarily connected by a transverse commissure, or a bridge of dotted substance. Each sphere gives off a peripheral nerve, or a component part of one. Of these spheres there are eight in the cerebrum. The anterior give off fibres for the optic nerves; of those that succeed them, the outermost provide for the outer antennæ, and the others for the inner antennæ and optic chiasma respectively. In the sub-œsophageal ganglion there are seven pairs, five of which are connected by a bridge and commissure, and two by a bridge only. Each of the thoracic ganglia is provided with a pair; in the abdominal ganglia there are two pairs, one ellipse-shaped and one spheroidal; the caudal (post-abdominal) ganglia are found to have five pairs. The greater part of what follows is only intelligible to those who have Dietl's figures at hand, but it may be noted that the nerves arising from the ganglia are stated to be generally made up of two parts, and that the so-called giant nerve-fibres pass through the whole of the ventral cord.

Heart of the Crayfish and Lobster.—The following results are given by Deszsö * on this subject:—(1) There are five pairs of clefts on the dorsal surface, of which four are so small as to require careful search. On the ventral surface there are three pairs, two of which are very small. (2) The musculature of the organ is composed of *muscle-cells*, and not, as has been supposed by Weissmann and others, of mere *muscle-fibres;* these cells have the transversely striated substance on one surface only. The nuclei of the muscle-cells are provided with nucleoli, which may often be observed in the act of fission. In the lobster the anatomical elements are much smaller than in the crayfish. In the muscular wall of the heart there are eight hæmal spaces corresponding to the eight clefts, and these spaces unite in a central ventricle. (3) The pericardium is an elastic layer of connective tissue, in which a few small nuclei can be made out; it is not provided with any muscular elements. (4) In the posterior region of the dorsal part of the muscular heart, ganglionic cells, ordinarily bipolar, and invested in connective tissue, may be discovered. These are often united together by threes, or in a larger number; the largest of them were found to measure $\frac{9}{10}$ of a millimetre, their nuclei $\frac{36}{100}$, and their nucleoli $\frac{7}{100}$ of a millimetre.

The same author gives † a very brief account of the connection

* 'Zool. Anzeiger,' i. (1878) 126. † Ibid., 274.

between the circulatory and the respiratory organs in the Arthropoda. He finds that in Insecta, Myriapoda, and Arachnida there are as many pairs of clefts in the dorsal vessel as there are pairs of stigmata; that in the Crustacea there are, likewise, as many clefts as there are pairs of branchiæ; this obtains when the gills are set on the abdomen and post-abdomen; when, however, the gills are gathered under the cephalo-thorax, then there are in the heart as many pairs of clefts as there are pairs of gills under the shelter of this investment.

New Branchiopoda off the French Coasts.—M. Hesse describes* some new Crustacea, for which he forms a new genus—*Copechætes* (κώπη, oar, χαίτη, hair); as their relation to other forms will probably be of interest to naturalists, we append his table of classification, which, as he says, is based on that of Norman and Brady:—

Legion: *Branchiopoda.*
Sub-order: *Cladocera.*
Division: *Calyptomera.*
Tribe: *Anomopoda.*

Family—*Copechætidæ*	.. ..	*Copechæte*, Hesse.
" *Bosminidæ* ..	.. ..	*Bosmina*, Baird.
" *Macrotrichidæ*	.. ..	*Macrothrix*, Baird, &c. &c.
" *Lynceidæ* ..	.. ..	*Lynceus*, Müller, &c. &c.

Four new species, to which the names *elongata*, *affinis*, *fissa*, and *armoricana* are given, are described and figured; they are all of extremely small size, and are marine in habitat. No details can be given as to the history of their development, but eggs were found, which in some cases were strong and greatly elongated, and in others spherical; in the former case the enveloping membrane was thick, and the thinness of this investment in the latter case appeared to be due to its earlier condition of development. The detailed description which is given indicates the affinities of these forms to the *Bosminidæ*.

As single specimens—which, by the way, all belonged to females—were alone found, M. Hesse is unable to give any anatomical details; he states, however, that the antennæ were long and delicate, but that of these appendages only one pair was to be observed; as to the other, no definite statement is possible; the abdominal is much shorter than the post-abdominal region; this latter, or tail, has a truncated termination, which is very large and surrounded by a horseshoe-shaped pad; it is provided with two powerful muscles, which must evidently be of great assistance in locomotion. The branchiæ, which are elongated, are set towards the centre of the body; the enteric tube takes a direct course from before backwards. The eyes are seated on short broad peduncles, and can be moved laterally or in a line parallel to the long axis of the body.

They were observed to live 283 millimetres below the surface of the water, at which level they were probably supported by the air entangled in the valves of their shells; as in the *Bosminidæ*, the shells of the *Copechætidæ* form a hood-like protection for the anterior portion of the head, but they are at once distinguished by the different

* 'Ann. Sci. Nat. (Zool.),' vii. (1878), Nos. 5–6.

characters of the abdominal termination of the body, and by the presence on the thoracic appendages of hair-like setæ.

They have been obtained from below stones on the sea-shore, from the stomachs of a fish and of a *Medusa*, and from a mass of *Fucus*. The paper is illustrated by a plate.

On the Crustacea of the Mozambique.—The collection of Dr. Peters is described* by Hilgendorf in great detail, and illustrated by four plates, but the whole paper is too technical to allow of any brief account. It may be mentioned, however, that the number of known species from this region is multiplied by more than 4,—27 now becoming 128. Of the 101 forms new to this region, only one genus—*Podopisa*, one new sub-genus—*Myomenippe*, and seventeen new species are recorded. The only other collector in this region appears to have been Bianconi, and the importance of it to carcinology cannot be overestimated. The new genus appears to be intermediate between the *Macropodidæ* and the *Maiadæ*.

Vermes.

Pneumonia produced by a Filarian Worm.—M. Megnin has discovered† a new worm, which he proposes to call *Strongylus minutissimus*; this creature was observed by him in some African sheep which were brought over to Vincennes, and which suffered from purulent abscesses on the lung, although the bronchi were completely healthy. Clearly allied to *Strongylus filaria*, it differs from it by its much smaller size—1 (male) to 1½ (female) centimetre, while the tail is very short, and the embryo is provided with a short caudal prolongation; the habits also are different; the fecundated females become encysted in the pulmonary tissue, where they die after giving birth to the embryos, which escape by the bronchi; the dead give rise to inflammatory processes in the lung. Development appears to obtain externally to the host, just as in *Strongylus filaria*, and other pests of the fowl, and *Oxyuris incurvata* and *Strongylus armatus* of the horse. Ova and embryos placed in damp earth were found living after fifteen days, but no other changes have yet been observed; further investigations on the subject are, however, promised.‡

On Sagitella (Wagner).—Although M. Uljanin states that what observations he has to offer § on this interesting annelid are merely rough notes, they are of sufficient value to demand very careful attention.

Tegumentary System.—The cuticle is a fine, transparent, strong membrane, which may or may not be striated; it does not appear to cover the anterior part of the buccal segment or the elytra; the greater part of the hypodermis is made up of a very fine protoplasmic layer,

* 'MB. Preuss. Akad. Wiss.' (Nov. 1878), 782.
† 'Bull. Soc. Centrale Vétérinaire' (1877), 646.
‡ 'Journ. Anat. et Phys.' (Robin), xiv. (1878) 548.
§ 'Arch. Zool. Expér. et Gén.,' vii. (1878) 1.

in which are set a large number of nuclei, each provided with two or three highly refractive nucleoli; the apparent absence of this layer in sections of the worm, which have been treated with acetic, osmic, or chromic acid, is explained by an account of what happens in the fresh creature when it is submitted to these reagents; the protoplasm contracts, and forms more or less oblong masses of varying size, which are separated from one another, and contain two or even three nuclei. In the anterior part of the buccal segment this layer is thick, but Uljanin was unable to make out the separate cells. The elytra are each formed of a somewhat opaque nucleated mass, which is made up of a number of small, distinct cells, each provided with a large nucleus, and of larger bodies, which appear to form unicellular cutaneous glands, such as are so common in the integument of all *Chætopoda*. True cilia seem to be almost completely absent; the buccal segment of two species is, however, provided with a ventral and a dorsal hood, the edges of which are provided with a row of long lamellæ, which on close examination are seen to be made up of a number of united cilia, which so far seem to be just the same as the lamellæ of the *Ctenophora*.

The subjacent muscular layer is arranged in two sets; the outer, in which the bands seem to be circular, is really composed of large bands, separated from one another by spaces almost as large; the elements of these bands are cylindrical, and are altogether similar to those so commonly found in the *Annelides*. The lower layer consists of longitudinal muscles, the elements of which are greatly elongated, narrow at either end, and provided at one edge with small outgrowths containing a finely granular substance (cf. the "nematoid fibres" of Ratzel).

Nervous System.—Uljanin contradicts N. Wagner's description in almost every point; he asserts that what this author took for the cerebral ganglionic mass, is merely the glandular portion of a retort-shaped organ which lies above the œsophagus; while he further states that there is a true ganglionic chain, and not merely two flattened nerve-trunks. At the end of the body of the worm there appears to be a tactile organ, but the most curious portion of the sensory apparatus is represented by the small rod-like bodies which are connected with the elytra; when highly magnified, an elytron is seen to contain in its tissue a number of curved filaments, the two ends of which are set towards its surface; some of these spread out into a fan-like termination, and others remain more compact: the filaments are very fine and highly refractive, and are connected at their ends with spherical and likewise highly refractive corpuscles, of two distinct sizes, and with elliptical bodies of a similar character. Our author is merely content with drawing attention to this apparatus, which he cannot believe to be made up of spermatozoids, much as they resemble them at first sight.

Digestive Organs.—The mouth is situated at the middle of the ventral surface of the buccal segment and above the ventral hood; the œsophagus is short and thick-walled; the intestine largest more anteriorly, and the anus is placed on the dorsal surface of the posterior segment; above the œsophagus there is an elongated organ, which

the animal can be induced to protrude on irritation with acetic acid, and which it moves at short intervals in a longitudinal direction; examination by the aid of sections of the buccal region shows that this organ belongs to the enteric tract, inasmuch as it is lodged in a saccular fold of the œsophagus; no very definite account can be given of its function, but it is presumed to secrete an offensive liquid; the walls of the intestine are remarkable for the presence of enormous cells in the epithelium, very similar to those which are found in the same region of some larval annelids.

The perivisceral cavity is largely occupied by connective tissue, at the expense of which it is probable that the generative elements are produced.

Segmental Organs.—All but the buccal segments are provided with a pair of segmental organs; those of the fifth segment are not, as are the others, long and sinuous, but are shorter and broader, and are evidently efferent ducts for the sexual products.

Reproductive Organs. — The *Sagitellidæ* are hermaphrodite; in mature specimens the whole of the cœlom was observed to be filled with ova and spermatozoa; the former oblong, the latter with a spherical head and a short tail. Passed out by the ducts of the fifth segment, the ova appear to remain for a time in connection with their parent, and under the protection of the elytra of the fourth and fifth segments. They do not appear to undergo any metamorphosis, but in the young the elytra form soft pads, and the lamellæ of the hoods are formed of separate cilia.

Zoological Position.—Satisfied as to their belonging to the *Annelida-Chætopoda*, M. Uljanin proceeds to inquire whether they should be placed with the *Oligochæta* or *Polychæta;* the covering of the segments, the absence of muscular bands in the cœlom, the characters of the segmental organs, are all points which distinguish them from the latter; the tentaculiform appendage of their buccal segment is not found among the *Oligochæta*, while the presence of one or two pairs of elytra on all the segments distinguishes them from both these groups; but these elytra are merely modified parapodia, and the characters of the tentacular appendage are not sufficient to justify their separation from the *Oligochæta;* they must, nevertheless, form a distinct group, for which a name is taken from the small annelid described by Busch, which seems to be a close ally of *Sagitella*—*Typhloscolex;* the chief characters of the *Typhloscolecidæ*, then, are these:—

Body oblong, and consisting of a varying number of segments; the anterior or buccal segment is provided with one or more tentaculiform appendages, and with cilia, or with lamellæ formed of cilia; all the segments of the body carry one or two pairs of elytra. Some or all (with the exception of the buccal segment) are armed on either side with a few short spine-like setæ. Pelagic.

The two genera — *Typhloscolex* Busch (1851), and *Sagitella* N. Wagner (1872)—are then defined, and of the three species of the latter, *S. Kowalewskii* Wagner, and *S. barbata* and *S. præcox*, which are new species, there follow short diagnoses: the animals have been found at Trieste, in the Red Sea, and in the Mediterranean.

Echinodermata.

Embryogeny of Asteriscus verruculatus.—Barrois has extended his embryological investigations to the *Asteroidea*, of which group the development of *Asteriscus verruculatus* is described.* He finds that the gastrula is of the primitive type, that it grows into a large, ciliated, and completely closed sac, and then becomes trilobed; the two side lobes fall away and the young asterid is developed from the median portion. By invagination of the endoderm the enteric canal becomes divided into three parts, the two lateral sacs being peritoneal, and completely surrounding the middle one. The mouth, as in most, is formed by the invagination of the ectoderm, which pushes its way in between the two peritoneal sacs. The enteric cavity likewise gives rise to the water-vascular system.

The star-shaped form of body is due (1) to the flattening of the rounded large (median) lobe of the embryo; this is effected from behind forwards, and affects the intestine and the parts annexed thereto; (2), between the anterior and posterior surfaces thus formed there arise ectodermal thickenings which grow into the arms; of these, one arises at the most anterior point, and the two others on either side; (3), the development of the water-vascular system into a ring round the mouth. The peculiar point in the structure of this asterid at this moment is the great degree of asymmetry which it exhibits, owing to the much greater development of the superior as compared with the inferior surface, and the excentric position of the mouth; this want of symmetry gradually disappears, owing to the mode of growth now followed; as this goes on, the ambulacral lobes are seen to divide into five branches; at first three lobes are seen, and then five are formed by the trifurcation of the median lobe.

As time goes on, the intestine gives off five cæca, and becomes provided with an anus; and the calcareous plates take on a definite arrangement.

The most important points are henceforward associated with the elongation of the arms and the increase in the number of the ambulacral joints, which is effected in just the same way as is the multiplication of the "zonites" of annelids.

Comparing this form with those in which there are intermediate larval stages, we may note that, in *Asteriscus*, the endoderm grows out into a large sac, from which the intestine, peritoneal sac, and water-vessels are directly differentiated, whereas in the others the endoderm forms the intestine, and it is this intestine which gives rise to the other organs; in the young starfish three regions, dorsal, ventral, and lateral, can be made out; the observation that the ambulacra exhibit the same mode of increase as the *Annelides* may be applied to the *Echinoidea*, as well as to the *Asteroidea*.

On the Skeleton of the Asteriadæ.—An article † on this subject, by M. L. Viguier, consists of an historical introduction, a careful and detailed description of the composing parts, and an account of a number of genera. His chief conclusions are:—

* 'Journ. Anat. et Phys.' (Robin), xv. (1879) 1.
† 'Arch. Zool. Expér. et Gén.,' vii. (1878) 33.

1. The study of the skeleton, which has hitherto been neglected, and which is by many naturalists regarded as incapable of furnishing any characters useful in classification, is shown to be "the only means by which the different genera of this class can be rationally distributed in natural groups."

2. The mouth, whatever be its type, is made up of a number of ossicles, of which there are five times as many as there are arms.

3. The mouth is limited by a number of pieces, of which there are four times as many as there are arms; these pieces are set in pairs, one of which—*ambulacral*—forms the extremity of the ambulacral grooves, while the others—adambulacral pairs—are set between these; above the adambulacral pairs, and exactly interambulacral in position, is an azygos piece, to which the name of *odontophore* is given.

4. This mouth is formed on one of two types:

(α) In one the ambulacral pairs extend into the interior of the mouth, and limit its contour—*ambulacral* type.

(β) In the other the adambulacral pairs extend into the interior of the mouth—*adambulacral* type.

5. These two groups characterize the two sub-classes into which M. Viguier divides the Asteroidea; one, containing the *Asteriadæ*, *Heliasteridæ*, and *Brisingidæ*, has the ambulacral pairs horizontal, the adambulacral pairs truncated, and an "odontophore" which is not provided with apophyses, and which forms a massive body, capable of but a slight amount of movement; in the other group, of which the *Echinasteridæ*, *Linckiadæ*, *Goniasteridæ*, *Pterasteridæ*, and *Astropectinidæ*, are the more important forms, the "odontophore" is ordinarily provided with apophyses, and the adambulacral ossicles are not so completely truncated.

6. This classification accords with the results which M. Edmond Perrier has gained from the study of the characters of the pedicellariæ, so far as they are present to afford assistance in this difficult operation of arrangement.

7. The teeth and the "odontophore" vary in form in the various genera, and in many cases even in the various species.

8. The so-called "odontophore" seems to be homologous with what Müller called the osseous peristomial plates of *Euryalus*, and with the corresponding parts in *Ophiura* and *Ophiocoma*; in extending his survey to the *Echinoidea*, the author finds, as is natural, greater difficulties in his way, and he is content to insist on the morphological resemblances presented by the "tooth" of the dentate forms (*Desmosticha*; *Cassidulidæ*) when compared with the "odontophore" of the starfish.

No examination of any morphological characters in the *Echinoderma* seems to be complete in these days which does not take into account the corm theory of Haeckel, which, as we are informed by its author, is "as yet the sole theory attempting the genetic explanation of this remarkable group of animals;" * and, indeed, the position and the great value of the speculations of the German zoologist do demand

* 'Evolution of Man,' Engl. transl., ii. 480.

a most respectful attention; facts, however, seem to be against him here, and M. Viguier brings some new considerations to our notice; the fact that Duvernoy in 1837 spoke of "cinq colonnes vertebrales" in *Asterias*, and that he called the starfishes "serpents à plusieurs corps, et à une seule bouche," is worthy of notice; much more so are the following points: the general skeleton of no asterid ever presents a regular segmentation, corresponding to that of the ambulacral and adambulacral series, nor are the radial cæca divided in correspondence with the segments of the body as they are in all annelids. As we are on debatable ground we may, as a matter of criticism on the arguments of, and without any desire to object to the final conclusions of M. Viguier, point out that the segmentation of the vertebral column of the adult bird and mammal does not correspond to that exhibited by the episkeletal muscles or spinal nerves, and yet the metamerism of the Vertebrata is as certain as any fact in morphology.

Cœlenterata.

Researches into the Hydrozoa.—Professor Claus has communicated * to the Vienna Academy a long and elaborate paper on such forms as he has observed in the Adriatic.

In the hermaphrodite *Chrysaora* the development of the embryo is effected within the ovary; the ovarian cells are formed in the lower cell-layer of the ovarian region, the upper layers of which form part of the gastric epithelium and are richly provided with urticating capsules; as the cells increase in size, they project into the homogeneous layer which separates the upper from the lower (germinal) portion, and gradually become provided with a stalk, which is formed at the expense of the neighbouring cells, and, later on, with a follicular investment of flattened cells; fertilization is followed by cleavage into two cells of unequal size, and in the succeeding stages of segmentation the spheres produced are also unequal; at the point where the larger cells are found an ingrowth commences, and the endodermal tube, which rapidly extends to the opposite pole, begins to be formed; in the primary cœlom of the resulting elongated *Gastrula*-larva a clear fluid is developed; the next succeeding stages could not be observed.

A point of much interest in the history of this form is that embryonic development goes hand in hand with growth; in most *Acalephæ* cleavage does not commence until the ovum has attained its full size, but in *Chrysaora*, just as in the viviparous *Aphides* and in the *Polyphemida* (*Cladocera*), development commences while the ovum is still very small, and long before it has obtained its full amount of nutrient material, which in the animal under description is obtained from the already mentioned follicular cells. When the blastopore is closed we get a larva of which the two cell-layers are very different in character; the ectoderm is formed of cylindrical cells, richly provided with urticating capsules of three different forms; the anterior end of the free-swimming larva is much broader than the hinder end, and the cilia form a broader fan.

* 'Denkschr. Acad. Wien,' xxxviii. (1878) 1.

After tracing the history of the *Scyphistoma* and *Ephyra* stages, Claus concludes with observing that there is no fundamental difference between the *Medusæ* and the *Polyps;* the *Scyphistoma* is a polypoid *Medusa*, and the *Medusa* a broad, discoid, flattened Polyp, which has ceased to be fixed, and has become adapted to locomotive habits by the aid of its swimming bladder; the "grappling lines" are the marginal tentacles; the radial pouches of the gastro-vascular system are represented by the radial vessels, while the gelatinous disk forms a very strong mesodermal layer, which develops into a supporting lamella in the *Hydroida*, and a skeleton in the *Anthozoa*.

The rays along which are set the genital pouches (and marginal bodies) are regarded as rays of the second order, which are developed at an angle of 45° to the four primary tentacles, or rays of the first order; while the name of intermediate rays is given to the eight rays of the *Ephyra* form in which the tentacular vessels are developed.

Acalephæ and Hydro-medusæ.—In the opinion of Professor Claus, the differences between these forms have never been satisfactorily stated; the names *Cryptocarpæ* and *Phanerocarpæ*, or *Gymnophthalmata* and *Steganophthalmata*, or *Craspedota* and *Acraspoda*, which we owe to Eschholtz, Forbes, and Gegenbaur, are insufficient, for the large and complicated marginal bodies of the *Acalephæ* correspond, from a morphological point of view, to tentacles; the cavities in the substance of the umbrella in which the generative organs of the *Cryptocarpæ* are placed, are found to be present in a number of the *Phanerocarpæ;* neither in structure nor in position is there any fundamental difference between them. A more valuable point of difference is to be seen in the presence or absence of the filaments which appear to form tentacular appendages to the generative organs; the *Steganophthalmata* (*Discomedusæ*) are stated to be *Scyphistoma Medusæ* with filaments, while the *Gymnophthalmata* are *Hydroid Medusæ* without filaments. With these considerations in mind, Claus has lately addressed himself to the examination of the characters of the *Charybdeidæ* and *Æginidæ*, which had been placed by Fritz Müller with the *Hydro-medusæ*, and by Agassiz among the *Acalephæ* (*Discophora*). The great similarity in the external form of the bell and of the manubrium in *Charybdea* and *Oceania*, as well as the presence in both of four primary rays, have been used as arguments for uniting these forms; but the number of the radial canals, marginal bodies, and tentacles vary very greatly in the latter, and it appears to be allied to the *Hydro-medusæ*, while *Charybdea* presents distinct points of resemblance to the *Acalephæ;* judged by the point on which Claus insists, the *Oceanidæ* are found to want the gastric filaments.

Spongicola fistularis, a Hydroid inhabiting Sponges.—A *résumé* is given in M. Lacaze-Duthiers' 'Archives,'* of the observations of F. E. Schulze on the above-mentioned form, the chief interest of which is that it bears on the assertions of Eimer that the *Spongiæ* are provided with nematocysts; bearing in mind the changes in the zoological scale which the researches, chiefly of Professor Haeckel,

* 'Arch. Zool. Expér. et Gén.,' vii. (1878), Notes, ix.

have shown to be necessary for the *Spongiæ*, any further information is obviously important. In two siliceous sponges and in a horny sponge Eimer observed a number of canals, which enclosed a whitish body, which contracted on irritation; believing this to be part of the sponge, and rejecting the idea of its being hydroid in character, Eimer proposed to call it the *prehensile animal* (Fangs-thier). Two English observers, Mr. Carter and Professor Allman, have since 1872 observed similar cases, and they have both regarded the "Fangs-thier" as a hydroid; to this conclusion Schulze is also led. He says that in no case that he has examined can he regard the nematocysts as forming an integral part of the sponge-body; in all cases they have been observed on the surface or in the canals which are so characteristic of these lowly forms, and in all cases it has been easy to demonstrate that they are intruders. The four sponges examined belonged to the genera *Reniera*, *Suberites*, *Esperia*, and *Myxilla*. As the characters of this form are found by Schulze to correspond to the description given by Eimer, with the sole exception of their structural continuity with the sponge, it does not seem necessary to enter into further details; the accounts of Carter and Allman are stated to be too short to allow of any satisfactory comparison.

As to the development of this *Spongicola*, no information was obtained; but the author is of opinion that it belongs to the Hydroida or Hydro-medusæ, although there are indications of a *Scyphistoma* stage, such as is seen in the common *Aurelia aurita*, with which there are certain other points of agreement in the histological and morphological details.

Deep-sea Siphonophora. — Professor Studer's observations * are reviewed in M. Lacaze-Duthiers' 'Archives.'† The author points out that there are indications of a fauna intermediate between that of the surface and that of "abyssal" depths: during the voyage of the 'Gazelle,' *Siphonophora* were obtained, which can be satisfactorily shown to have come from depths varying from 500 to 2000 fathoms and from a region in which the temperature was from 2° to 6°. Two new species of *Rhizophysa*—*R. conifera* and *R. inermis*—are described, as is also a new genus, *Bathyphysa abyssorum* (1880 fathoms). The author calculates that the air-sac acts in just the same way as in those species that live near or on the surface.

Histological Characters and Development of Myriothela.—Herr Korotneff, of Moscow, makes some brief observations ‡ on this subject, the interest of which has been increased of late years by the work of Professor Allman. Dividing the body into the three regions of foot, median region, and upper region, he proceeds to point out how they differ; the walls of the body everywhere consist of ectoderm, supporting lamella, and endoderm. The ectoderm consists of several layers, in which three distinct sets of cells may be made out. Below the *superficial* layer there is a layer of subepithelial embryonic cells, in which the

* 'Zeitschr. f. wiss. Zool.,' xxxi. (1878) 1–24.
† 'Arch. Zool. Expér. et Gén.,' vii. (1878), Notes, xiii.
‡ 'Zool. Anzeiger,' i. (1878) 363.

nematocysts are developed, and a fairly well differentiated layer of muscular fibres which run parallel to the long axis of the body. The supporting lamella, in addition to the cells on its outer surface, which Professor Allman regarded as *neuro-muscular*, has also cells on the inner aspect which, as the Russian observer points out, are *flagellate endodermal muscle-cells;* in addition to these there are in the endoderm outgrowths (blastostyles), which are conical in form and centripetal in direction, and which consist of large cells containing brown pigment granules and giving off amœboid processes and flagella; by the aid of these plasmatic processes the cell is enabled to feed itself directly, while the flagella serve as tactile organs.

The blastostyles, which carry the gonophores, differ in structure from the "body" in the feeble development of the subepithelial and muscular layers, the latter indeed being altogether absent in young blastostyles; the supporting lamella has no projecting processes, and the ectoderm varies in character with the age of the blastostyle; just below the supporting lamella there are large dark-coloured cells, whence are developed the generative elements.

In the foot the ectodermal cells are five or six times as long as the ordinary cells, are coarsely granulated, and may be converted into gland-cells, which secrete a strong chitinous outer layer by which the whole of the foot is covered. The cells for the nematocysts are also present in somewhat large numbers, while the muscular layer is absent. The supporting lamella is without any outgrowths, and the endoderm is of the ordinary type.

The tentacles consist of muscular epithelial cells, such as were first observed by the author in *Hydra fusca*, and have since been seen by the brothers Hertwig in the *Medusæ*, together with a supporting lamella and a simple endodermal layer. In the capitular portion of the tentacle four kinds of nematocysts may be observed, three of which are supplied with tactile hairs. Between the nematocysts there are elongated pigmented cells, while the supporting lamella is highly developed, and broken up into fibrillæ which take a centripetal direction.

Tentacular structures (claspers) are found between the blastostyles; these serve for the attachment of the developing ova, and, though structurally similar to the tentacles, differ from them in having the ectodermal layer differentiated into glandular cells, which serve to attach the ova. The statement of Allman that these structures function in fertilization is not supported by M. Korotneff.

In continuation of his researches, Korotneff* describes the development of the gonophores; the large embryonic cells at the base of the endoderm of the blastostyle become collected together at various points; this "agglomeration" passes through the ectoderm, and forms an elevation on the surface; the peripheral cells of this "gonogenetic chamber" (Allman) become provided with refractive granules, which form a covering for the egg. One of the cells of the collection increases greatly in size and absorbs its neighbours; impregnation

* 'Zool. Anzeiger,' ii. (1879) 187.

takes place, and the egg escapes, to be seized on by the "claspers." The plan of development of the sperm-cells is of the same character; after impregnation the endoplasm of the egg is seen to become possessed of a number of cells which move towards the periphery and pass into the ectoplasm, where they form the blastoderm; between the cells of these two regions a differentiated lamella soon appears, which will go to form the future supporting lamella: the endodermal mass becomes fissured in anticipation of the gastric cavity, while the ectoderm gives rise to ingrowths, which are soon converted into the larval tentacles of *Myriothela*. The free actinula-embryo has no mouth, and nutrition is effected by the remnants of yolk-spheres in the gastric cavity. As soon as the mouth is developed, the embryo becomes fixed, the primitive tentacles are absorbed, and the blastostyles developed. Compared with the calcareous sponges, *Myriothela* differs in the characters of its *gastrula;* but as is pointed out, these animals have a simple ovum without any nutrient material, while the siliceous sponges which have an ovum provided with nutrient material, do also form a "planula."

The mesoderm is stated to be incompletely differentiated, and to consist of two muscular layers, the upper of which is distinctly separated from the ectoderm, while the lower is intimately connected with the endoderm; these two layers are separated by the supporting lamella which is likewise mesodermal in origin.

Porifera.

Structure of the Aplysinidæ.—This family of horny sponges is treated of by Professor Eilhard Schulze in one of his important series of "Researches on the Structure and Development of Sponges." * The first part of the paper consists of an historical *résumé* of former work on the family, and enumerates the genera belonging to it, namely, *Aplysina*, *Verongia*, *Dendrospongia*, *Darwinella*, *Janthella*, and the author's new genus *Aplysilla*. To this follows an anatomical and histological description of *Aplysina* and of *Aplysilla*.

1. *Aplysina aërophoba*.—Of the account of this already well-known species, our space will only allow of our noticing the histological portion.

The ectoderm consists of a single layer of flat polygonal cells with distinct nucleus and nucleolus. The boundaries between these cells are often seen only on treatment with silver nitrate, and in some cases even this treatment failed to reveal cell contour, owing to the presence of a structureless cuticula, probably formed under abnormal conditions for protective purposes.

The mesoderm consists of a sort of connective tissue made up of cells imbedded in a matrix, which is partly granular, partly (in the neighbourhood of the external surface and of the canals) hyaline. The cells themselves are mostly stellate, being provided with long, sometimes branching processes. But where the mesoderm surrounds the water canals, these cells become spindle-shaped, and surround

* 'Zeitsch. f. wiss. Zool.,' xxx. (1878) 379.

the canal like a layer of circular muscle-fibres: these have indeed been described as muscular elements, but Schulze prefers to call them "contractile fibre-cells."

Amongst the ordinary mesoderm cells, rounded cells are found without definite processes, and probably to be considered as amœboid wandering cells. There also occur remarkable structures of an irregularly rounded or knobbed form, about 10 μ in diameter, of a bright yellow colour and strongly refractile. Each of these consists of a number of small, globular, hyaline bodies, in close contact with one another: to their presence the yellow hue of the entire sponge is due. When exposed to the air, these yellow granules undergo a remarkable change of colour, becoming first pale bluish grey, then pure blue, and finally dark prussian blue: by this change the coloured bodies become at first more transparent, but finally quite opaque. The yellow colouring matter is turned brown by ammonia, and is slowly dissolved by ether and absolute alcohol, readily by acetic acid. Schulze considers these bodies to be accumulations of reserve material, analogous to the fat-cells of other animals, and to the starch of plants.

In the hyaline portions of the mesoderm occur very fine fibres, probably comparable to the connective-tissue fibrils of Vertebrates. In the neighbourhood of the ciliated chambers occur, scattered through the mesoderm, numerous small rounded granules, of a whitish colour by reflected light. There is no discernible bounding membrane (*membrana limitans*) either between mesoderm and ectoderm, or between mesoderm and endoderm.

The endoderm consists of collar-bearing flagellate cells in the hemispherical portion of the ciliated chambers, into which the afferent canal opens; while the funnel-like portion, leading into the efferent canal, is covered by the same tesselated epithelium as the rest of the internal cavities.

The fibres forming the skeleton of *Aplysina* are circular in section, and consist of a laminated horny cortex, enclosing a soft medulla which exhibits a delicate fibrillar structure. At the apex of the fibre, the lamellæ of the cortex are at a considerable distance from one another, and have the appearance of a series of superposed glove-fingers, the innermost of which exhibits perfect continuity of structure with the medulla, which is thus seen to be in no way essentially different to the cortex.

In autumn and winter, rounded masses consisting of cells with vesicular nuclei were found in the mesoderm of adult individuals: the further fate of these is unknown, but the author considers that they are probably spore-like reproductive bodies.

2. *Aplysilla sulfurea*, nov. gen. et sp.—A full description is given of this genus, which differs markedly from *Aplysina* in the fact that the horny skeleton does not consist of a regular network of fibres, but of isolated, simple or branched, terete fibres, each attached to a basal plate. With regard to the migratory cells occurring in the mesoderm, the author remarks that their presence proves the tisues in which they occur to be a true mesoderm, consisting of actual cells imbedded in a matrix or ground-substance, and answering to the connective tissue

of the higher animals; and not a syncytium, that is, composed of fused cell-bodies with imbedded nuclei.

Both the migratory cells and the collar-bearing cells lining the ciliated chambers contain in their protoplasm yellow pigment granules.

The sexes are distinct. The spermatozoa have an ovoidal head and a long delicate tail, and occur in definite aggregations, each enclosed in a special cavity of the mesoderm lined by a single layer of flat polygonal cells. Probably, as in *Halisarca*, each aggregation is formed by the repeated division of a single cell. The ova are contained each in a similar cavity of mesoderm: the vitellus is opaque, owing to the large number of yolk-granules: there is an excentric germinal vesicle and refractive germinal spot. Probably the eggs, like the aggregations of spermatozoa, result from mesodermal leucocytes.

Only one developmental stage of *Aplysilla* was observed — the blastula phase. This consists of an oval body, covered with a single layer of cylinder cells, each provided with a long cilium, and enclosing not, as usual, a clear fluid, but a definite tissue, consisting of stellate cells with anastomosing processes. From this it seems probable that the mesoderm in *Aplysilla* is formed actually before the gastrula stage.

The other species of this genus, *A. rosea*, is remarkable from the fact that it is hermaphrodite, young eggs and sperm-aggregations being found in one and the same section.

Structure of Spongelia.—In a memoir on this genus of horny sponges, F. E. Schulze * gives, besides an historical summary and enumeration of the species, a full description of *Spongelia avara* and of *S. pallescens*, and short accounts of *S. elegans* and *S. spinifera*. The genus itself is distinguished, according to Schulze's observations, by the following characters.

1. The possession of large, simple, saccular, ciliated chambers, which are provided with numerous inhalent pores, and possess a wide, round, exhalent aperture, opening directly into one of the efferent canals.

2. The complete absence of highly refracting granules in the matrix of the connective tissue surrounding the ciliated chambers.

3. The extensive enclosure of foreign matters by all the chief fibres of the skeleton; the thin connecting fibres may or may not contain foreign particles.

4. The more or less uniform development of conical elevations (conuli), ½–8 mm. high, and the same distance from one another, over the whole surface of the sponge, with the exception of the area surrounding the osculum.

S. avara.—The skeleton in this species consists of a network of fibres of spongiolin, in which are imbedded great numbers of foreign bodies, the chief of which are broken spicules of other sponges, both siliceous and calcareous, fragments of plates and spines of Echinoderms, shells of *Foraminifera* and sometimes of *Radiolaria*, as well as fragments of the hard parts of worms, molluscs, &c., and sand-grains.

* 'Zeitsch. f. wiss. Zool.,' xxxii. (1878) 117.

The arrangement of these foreign bodies is very irregular; they are always, however, situated in the axis of the horny fibre, and those of an elongated shape have their long axis set as nearly as possible in the direction of length of the fibre. It looks, at first sight—so completely is the true skeleton of the sponge interpenetrated with these extraneous matters—as if they were the exciting cause of the formation of the skeleton; but this is shown not to be the case, from the fact that spongiolin fibres were found, exhibiting a concentrically laminated structure, and quite free from foreign bodies. These latter, therefore, are not essential to the formation of the horny skeleton, but are probably adjuvant to it.

The disposition of the fibres is very irregular: they exhibit no distinction into vertical and horizontal fibres, but in each of the column-like elevations of the sponge it is seen, in a longitudinal section, that there are eight or ten more or less longitudinal main fibres, between which is an irregular network of fine connecting fibres.

The roundish pores in the ectoderm lead into irregular lacunæ or "subdermal spaces," from which afferent canals branch out into the interior of the sponge, and finally open by minute pores into one of the ciliated chambers, each of which has from twenty to thirty pores. The ciliated chambers are disposed radially round the efferent canals into which they open directly by a wide aperture, there being no intermediate passage or efferent duct between the two. The efferent canals finally debouch into one of the wide cloacal cavities, at the extremity of which is an iris-like contractile membrane serving to regulate the width of the osculum.

All those parts of the sponge which are bathed with water, except the ciliated chambers, namely the external surface and the afferent and efferent canals, are lined with a single layer of flat polygonal cells, constituting the outer cell-layer or ectoderm.

The mesoderm, or connective-tissue layer, consists of a hyaline gelatinous matrix, with imbedded star- or spindle-shaped cells, the processes of which often anastomose. The refracting granules which, in most horny sponges, occur in the mesoderm surrounding the ciliated chambers, are wholly absent. Contractile fibre-cells occur, as in *Aplysina*.

The endoderm consists of the flagellate cells lining the ciliated chambers: in these are contained lilac or rose-coloured granules, to which the tint of the entire sponge is due.

The morula stage was the only phase of development which the author was enabled to observe.

In *Spongelia pallescens* aggregations of spermatic cells were found in definite cavities of the mesoderm, lined with a single layer of flat cells. The ciliated embryos of this species were also examined. They have the form of a cylinder, with one end slightly convex, the other slightly excavated: the latter has a strong brown-red colour. The body is covered by a single layer of columnar ciliated cells, surrounding a central mass having much the same characters as the mesoderm of the adult.

This species is remarkable for being infested by two species of

parasitic alga, *Callithamnion membranaceum* and *Oscillaria spongeliæ* (n. sp.).

Protozoa.

Evolution of the Infusoria from the Lower Protozoa.—In some speculative observations on the probable steps in and causes of the evolution of the *Infusoria* from the lower *Protozoa*,* Mereschkowsky remarks upon the (as a general rule) total absence of symmetry in the *Infusoria*, and considers that this is explained by the close genetic connection between that group and *Amœbæ*. The first step in the differentiation of the latter was probably a hardening of the superficial layer of protoplasm, and with this was connected a proportional thinning and lengthening of the pseudopodia, and a slowing of the animal's movements. With the gradual induration of the superficial layer of protoplasm, there seems to have come about a greater and greater restriction of the area suitable for the inception of nutriment; in this way the infusorial mouth was produced. But as the ingestive area became less, it became more and more necessary that the animal should have the means of rapid locomotion, and so be able to make up, by active foraging, for the lost power of taking in any suitable food-particle which might happen to come in contact with any part of its surface. In response to this want, it would seem that the variously disposed cilia and flagella of the *Infusoria* came into existence by the action of natural selection.

Acinetæ and Vorticellæ.—Biologists, as is well known, have never yet accepted the views of Stein as to the *Acinetæ* being stages of development of *Vorticellæ*, &c., mainly from the fact that his observations have not been confirmed by other observers. Mr. H. E. Forrest, one of the secretaries of the Birmingham Natural History and Microscopical Society, in describing what he terms "Acinetation" in the *Vorticellæ*,† states that "last October, while examining some *Acinetæ*, he saw a small *Vorticella* burst from the body of one of them and swim away."

Researches on the Acinetæ.—M. Fraipont, in continuation of the results of his investigations on the *Acinetæ* found on the Ostend coast, publishes three parts of his memoirs,‡ in which he deals with the structure of some well-known and of some new species, and also with the general characters of the group; to this last we will first address ourselves.

Skeletal membrane (Hertwig).—The presence of this structure and its morphological characters have been the subject of considerable doubt and dispute; Claparède and Lachmann regarded it as a calyciform covering of resistant character; Stein asserted that in addition to this there was an internal membrane, while Hertwig has drawn attention to the differences presented by *Acinetæ* as compared with *Podophrya*; in *Acineta* Fraipont always found an internal membrane covering the surface of the protoplasm, at all points where this was

* 'Arch. f. Mikr. Anat.,' xvi. (1879) 153.
† 'Midland Naturalist,' ii. (1879) 88.
‡ 'Bull. Ac. Roy. Belg.,' xlv. (1878) 247, 287, 475.

separated from the outer covering; the cavity between the two investments may be single or divided into different parts, according to the extent to which the protoplasm is separated from the outer coat, and it is on the separated parts, and these only, that the second or inner covering is developed, and it is to be regarded as nothing more than a newly formed cuticle.

The stalk is not always developed, and, where it is, it may be merely a continuation of the wall of the body, or it may also have protoplasmic contents; in either case it varies greatly in character.

The tentacles.—While Lachmann was the first to point out the suctorial nature of these appendages, it is to R. Hertwig that we owe our knowledge of the fact that they are not always suckers, but that they may remain of a lower grade of differentiation and be simply prehensile filaments; and again, the same organism may present tentacles of the two types. Varying as they may in position and in arrangement, it is clear that, from a morphological stand-point, we have to do with a single type of structure. Looked at thus broadly, a tentacle is formed of a wall, and of the contained protoplasm; but it is something more than the pseudopodia, with which Stein, Haeckel, and Gegenbaur would compare it; it is covered by the cuticle of the skeletal membrane, and there is evidence of a differentiation of the protoplasm along the axis of the tentacle, and in the higher forms there is a spiral filament differentiated in this part.

As to the *symmetry of the body*, we find all kinds of modifications; bilateral, quadrilateral, pyramidal, radiate, or none at all.

Protoplasmic contents.—The protoplasm is of very nearly the same character in all *Acinetæ;* there is a delicate outer layer, which is finely granular, and a more opaque medullary mass, which is often pigmented; the endosarc is more fluid than the ectosarc, and may contain small shining bodies, which are spherical or navicellar in form, and closely resemble the trichocysts of the ciliate Infusoria. In this substance two kinds of vacuoles may be distinguished; one, set irregularly and varying in form, while the others are pulsatile, and vary in number in different species; they appear to be always found near the surface of the ectosarc, and though undergoing a systole and diastole do not vary in position; with regard to these structures it is of great interest to observe that in some cases the presence of an excretory canal has been noted by some observers. The nucleus appears to vary in character, from a spherical or ovoid form to arborescent structures of great complexity, and the study of one of these latter shows that it passes through all the possible intermediate stages.

Reproduction may be effected in one of three ways; the first and simplest is by fission, but this is rarely observed; the second is by gemmation, and the third by the formation of embryos within the body of the parent; but with regard to these modes, the author has but little to say from his own observations.

With regard to the *classification* proposed by M. Fraipont, we could only deal with it satisfactorily by giving it in detail, and we must therefore be content to make two observations, and to refer those who

are specially interested in the subject to the paper itself. Basing his views on the classification of Claparède and Lachmann, he elevates their eight genera—*Podophrya*, *Sphærophrya*, *Trichophrya*, *Acineta*, *Solenophrya*, *Dendrosoma*, *Dendrocometes*, and *Ophryodendron*—into eight families, to which he adds the *Urnulida*; of these the *Trichophrida* are regarded as the lowest, and the relations of these to the rest, and of the rest to one another, are indicated in a phylogenetic table.

As to the affinities of the group, the formation of internal embryos, the ciliation, and migratory habits of these embryos, are, with certain other points, indications of their affinities to the *Ciliata*, from which they seem to have been derived.

With regard to the more detailed observations, of which only a brief mention can be made; *Acineta tuberosa* does not possess differentiated prehensile processes or suckers; all the tentacular organs, to which M. Fraipont gives the name of prehensile suckers, are similar in character; they are arranged in tufts on ten points of the body, and are only not rigid when they are seizing their prey, at which time they exhibit a high power of rapid movement. As a rule, it never possesses more than one contractile vacuole; the only mode of reproduction observed is that by internal gemmation. The new species *Podophrya Benedeni* is described as a magnificent form, in which four contractile vacuoles can be made out, and in which the two kinds of tentacular processes already described may be observed: reproduction is effected by external gemmation. The other new species described are *Acineta crenata*, *Acineta vorticelloides*, and *Podophrya truncata*. The first is of a dirty yellow colour, and has, as a rule, only one contractile vacuole, and there may be as many as twenty-six prehensile suckers: reproduction appears to be effected by external gemmation.

A few notes are also offered on *Podophrya Lyngbyi* Ehrenberg, in which the pedicle is about five times as long as the body, the prehensile suckers stout and numerous, and the protoplasm, as in so many of this group, coloured dirty yellow; one or two vacuoles are to be observed, and the nucleus has the form of a short rod, bent on itself. No observations are made as to the reproduction or development of this species.

The Noctilucæ.—In addition to the observations of M. Robin, to which we have referred at p. 331 of vol. i. and p. 195 of this volume, the *Noctilucæ* have been studied by M. W. Vignal.*

There is an entire disagreement between the results of Robin and Vignal on the subject of their contractility. According to Robin, there is nothing analogous to *muscular* contractility. He says that he has proved with Cadiat, that "induction currents have no influence whatever on the contractions of the tentacle, notwithstanding its striated condition, nor on the contraction of the flagellum or that of the sarcodic contents."

* "Recherches Histologiques et Physiologiques sur les Noctiluques," 'Archives de Physiologie,' 10th Nov., 1878.

Vignal is, on the contrary, convinced of the muscular nature of the tentacle. "On the establishment and breaking of the current," he says, "the flagellum (the tentacle of Robin) contracts in its usual manner; the contraction is more rapid and energetic at the breaking of the current. When I applied an induced current with rapid interruptions, the flagellum became tetanically contracted, and continued in this state for three or four minutes, then it gradually relaxed under the influence of fatigue." There would therefore be, according to Vignal, "analogy between the contractions of the tentacle, and those presented by the muscles of animal life." However that may be, the movements of the tentacle never lead the *Noctiluca* to change its place; they merely cause it, as Suriray has already shown, to oscillate in its place.

As for the phenomenon of phosphorescence, it is due, according to Vignal, to a property of the protoplasmic mass, to the exclusion of the other parts of the body. We know that the phosphorescence attains its maximum by the agitation of the water; according to Vignal, this is an effect of which the cause is merely the mechanical irritation of the *Noctilucæ*: experiment has shown him that if oxygen intervenes in the phenomenon, it is as a necessary agent to life, and not as an oxidizer. Whilst studying the influence of heat on photogeny, he observed that a temperature of 37° (C.) augments the phosphorescence and, above all, renders it more persistent, whilst a temperature of 39° kills the *Noctilucæ* almost immediately. Finally, Vignal maintains that electricity supplied by a Grenet pile, or by an induction apparatus, neither increases nor lessens the brilliancy of the light emitted, a result contradictory to those formerly obtained by De Quatrefages, Robin, and Legros.

In an analysis of the two papers by M. G. Carlet, from which we take the above, he remarks that neither Robin nor Vignal have observed the existence of the anus admitted by Professor Huxley, and it would seem, therefore, to be clear that the alimentary residues are rejected by the oral aperture, the sole orifice of the body. Professor Huxley also described in the *Noctilucæ permanent* stomachs, which it must be considered do not really exist—these are vacuoles in the interior of the body, of variable number and volume, which are displaced by the movements of the protoplasm; they contain diatoms and other alimentary corpuscles, and represent only temporary stomachs.*

The dead bodies of *Noctiluca miliaris* left upon a beach in Beaumaris Bay by the receding tide, are said to have been of an orange-red colour.†

Flagellum of Euglena viridis.—In a "Notice to Correspondents," in 'Science-Gossip,'‡ the editor mentions that the flagellum of a specimen of *Euglena viridis* sent to him terminated in a bulb. The bulb was used occasionally as a kind of sucker against the glass sides of the zoophyte trough.

* 'Rev. Internat. Sci.,' iii. (1879) 47.
† 'Sci.-Gossip,' No. 173, p. 113. ‡ Ibid., p. 119.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Chemical Composition and Function of Leaves.—A paper on this subject, by M. Corenwinder, appears in the 'Annales des Sciences Naturelles,'* of which the following is a summary:—

The leaves of plants, in their relation to the external air, are the seat of two distinct functions.

1. By their protoplasm they absorb oxygen, and are perpetually producing carbonic acid.

2. By their chlorophyll they inhale carbonic acid during the day only, and exhale oxygen.

When young the protoplasm predominates in the cells, the quantity of chlorophyll being small; during this period therefore the function of respiration overbalances that of assimilation, and leaves consequently exhale carbonic acid without interruption.

In proportion as the leaves increase in size, the protoplasm diminishes and the chlorophyll increases; the power of exhaling carbonic acid then rapidly decreases, and they begin to give off more oxygen. After this the process of respiration can be detected only by placing the plants in the dark, or at least in diffused light, i. e. by suspending more or less the action of the chlorophyll.

These observations, therefore, completely confirm the doctrine now taught by nearly all vegetable physiologists; that there is in plants only one kind of respiration, and that this is identical with the process of respiration in animals, viz. an absorption of oxygen and disengagement of carbonic acid; and that the function of chlorophyll is one of assimilation.

Fermentation in the Tissues of Plants.—Professor de Luca, of Naples, publishes† the results of a series of experiments on the production of alcohol in the leaves, flowers, and fruits of certain plants. They may be summed up as follows:—

1. Fruits in closed vessels remain unchanged for a longer or shorter time, whether in carbonic acid or hydrogen, in a vacuum or in a limited supply of air.

2. Under these conditions fruits undergo a slow fermentation, with disengagement of carbonic acid gas, nitrogen, and, in certain cases, of hydrogen, and with formation of alcohol and acetic acid, but without the intervention of any ferment. In closed vessels these changes are only incompletely effected, in consequence of the strong pressure of the gases developed and compressed into a small volume.

3. In a limited supply of air and in closed vessels the final results are identical with the preceding; but the oxygen of the air is absorbed by the organic substance of the fruits.

4. Leaves and flowers present the same phenomena as fruits in a

* (Botanique), vi. (1878) 303.

† 'Ann. des Sci. Nat. (Bot.),' vi. (1878) 286.

limited supply of carbonic acid, hydrogen, or air, or in a vacuum and in perfectly closed vessels. The gases developed exercise a strong pressure, under which an incomplete decomposition of the carbohydrates takes place, resulting in the formation of alcohol and acetic acid, but without the assistance of any ferment.

5. The same results ensue with fruits, flowers, and leaves, under the ordinary pressure, with a limited supply of carbonic acid, hydrogen, or air; but the decomposition is carried out so completely that, when the disengagement of gas ceases, neither sugar nor starch remains, but, in their place, abundance of alcohol and acetic acid.

6. Fruits, flowers, and leaves placed, under the ordinary pressure, in a limited supply of air, carbonic acid, or hydrogen, do not remain unchanged for any considerable time, but deteriorate, and the fruits in particular become reduced to a brown and gelatinous mass.

7. When the leaves, flowers, and fruits of certain plants disengage hydrogen during fermentation, and under the conditions specified, this gas probably arises from the decomposition of mannite, which is a sugar with excess of hydrogen. In fact, fruits, flowers, and leaves which contain mannite, when fermenting, disengage hydrogen in addition to carbonic acid and nitrogen.

8. When the receivers resist very strong pressure, and the substances are introduced in very small quantity, the sugar is almost completely decomposed.

Assimilation of Soda by Plants.—M. Déhérain, continuing his researches on the assimilation of mineral substances by plants, has now turned his special attention to soda.* The following are the chief results arrived at:—

1. That sodium chloride may be absorbed by plants that do not ordinarily contain any soda.

2. That when the roots come into contact with a complex solution, this absorption takes place only when sodium chloride occurs in considerable proportion in this solution, a condition not presented by ordinary arable lands. Hence the occasional absence of sodium from the ashes of terrestrial plants.

3. That the absorption takes place much more readily when the sodium chloride is presented only to the roots; but in this case it ceases to be indifferent; it is, on the contrary, utilized by the plant, as may be demonstrated by the following considerations:—

a. Haricots (on which the experiments were chiefly made) exhaust their cotyledons when their roots are plunged in a solution containing sodium chloride.

b. Haricots plunged in a very dilute solution take up the salt in much larger proportion than the water. The combination effected in this case between the salt and the tissues explains its more ready absorption.

These facts are readily explicable on the ordinary theory of diffusion (osmose). M. Déhérain completely confirms the previous observations of Peligot as to the feebleness of the tendency of plants to absorb soda.

* 'Ann. des. Sci. Nat. (Bot.),' vi. (1878) 340.

Nutrition of Phanerogamic Parasites.—M. Chatin forwards to the French Academy* the result of some investigations on the mode in which parasitic flowering plants derive their nutriment from the host. This is effected by means of a kind of conical pivot or peg, performing the double functions of an ordinary root, viz. to fix the plant, and to absorb nutriment. The extremity of this cone, although consisting entirely of parenchymatous tissue, has a remarkable power of forcing itself through the tissue of the host, even when this is of very great hardness. In certain cases, and especially in the mistletoe, lateral suckers are formed, in addition to the terminal one. The structure is the same in all important points whether the parasite obtains its nourishment from the root of the host, as in the case of *Thesium* and *Pedicularis*, or from the stem, as in *Cuscuta*, *Cassytha*, and *Viscum*.

Polyembryony, true and false, and its relation to Parthenogenesis.—Professor Strasburger's researches † upon the fecundation of the angiospermous Phanerogams show that the embryo-sac very seldom produces more than one embryonal vesicle which is fecundated or capable of being fecundated. The single constant exception to this rule known to him is that of *Santalum album*, which produces two, besides one or two orchids in which the embryonal vesicle occasionally divides into two. True polyembryony must therefore be very rare in Angiosperms. But seeds containing more than one embryo are of common occurrence in the orange, *Funkia*, *Allium*, *Nothoscordum*, &c. According to Strasburger, all supernumerary embryos in such cases are adventitious, originate outside the embryo-sac, by a kind of prolification in the nucleus, and are not fecundated at all. They appear in the form of minute cellular protuberances, which lengthen by degrees and push into the embryo-sac by a sort of hernia, or pierce their way into it, becoming in the ripe seed veritable embryos, which it is not easy to distinguish from the one resulting from the fecundation of the embryonal vesicle itself. Independent as these adventitious embryos are of fecundation, yet Strasburger could not obtain them in *Nothoscordum* when he had removed the stamens before flowering, and prevented access of pollen. But it appears that *Cœlebogyne* is a case of this kind, namely, one in which an adventitious embryo is habitually produced, instead of the normal embryo, which fails from the want of fecundation, the male plant not being in cultivation. It is stated that this is not a mere inference, but that Strasburger has traced the development of the embryonal vesicle in the ovule of *Cœlebogyne*, followed by its disappearance and resorption, and by the independent production of adventitious embryos in the manner above described.

This, then, gives an explanation of the long-disputed parthenogenesis of *Cœlebogyne*, and therefore of the less notable instances.

Parthenogenesis, it is then concluded, is only so in appearance; it is sometimes, and perhaps in all cases, "a prolification of the nucleus."

* 'Comptes Rendus,' lxxxviii. (1879) 108.

† 'Jen. Zeitschr. f. Nat.,' v. (1878) 647.

Now we should insist that since the result is "a true embryo" (equivalent in structure, position of radicle, and ultimate growth to the normal embryo), and not a bud, parthenogenesis is the correct term; and the very interesting and important conclusion attained is, that parthenogenesis results, not from the development of an unfecundated embryonal vesicle, as was supposed, but from the development of other and extraneous cells into an embryo; also that it is not very rare, since the adventitious or supernumerary embryos of various seeds are cases of this parthenogenesis.

Not the least interesting consideration is, that we have here a counterpart of what De Bary terms apogamy, instead of an analogue of it. Apogamy is a vegetative prolification from what should normally result in the product of sexual reproduction. Parthenogenesis proves to be the inverse of this, a vegetative production in the ovule of the normal result of sexual reproduction, viz. the embryo. And, finally, we have in these two modes, taken together, what was quite to be expected—a manifest and significant rendering of the hiatus between vegetative and sexual reproduction which Mr. Darwin may turn to account.

Some applications of this new knowledge may be made. It is quite possible that more embryos than we are aware of may be adventitious. Rather more than a year ago an abstract was given in the 'American Journal of Science and Arts,' of Mr. Francis Parkman's interesting paper on the hybridization of lilies. It may be remembered that the greater part of his hybrids exactly reproduced the female parent. The explanation suggested by him, and which he refers to in his paper, was that those plants were not really hybrids at all, but were from embryos originated without male influence. What then seemed the least improbable explanation, would now appear to be the one altogether probable.*

B. CRYPTOGAMIA.

Luerssen's Handbook of Cryptogamic Botany.†—The crying want so long felt by all botanists of a good handbook of cryptogamic botany, brought down to our present state of knowledge, is at length supplied, as far as German readers are concerned, by the excellent book before us. Though the work is designed in the first place for pharmaceutists, and is intended to deal especially with pharmaceutical products and their sources, this programme is far exceeded in the present volume. Starting from the classification of Sachs in the fourth (German) edition of his 'Lehrbuch,' the author takes every class and order of Cryptogams in succession, and supplies the reader with an accurate, succinct, and at the same time sufficiently full account of the morphology, physiology, and life-history of each. The result is a thick volume of 657 pages, with 181 admirable woodcuts, many of them new. It is easy to criticize Sachs's classification in many of its

* 'Am. Journ. Sci. and Arts,' xvii. (1879) 334.

† 'Medicinisch-pharmaceutische Botanik: zugleich als Handbuch der systematischen Botanik, für Botaniker, Aerzte u. Apotheker.' Bearbeitet von Dr. Chr. Luerssen. 1 Band, Kryptogamen. Leipzig, 1879.

details, and in some points it will certainly not be followed by future systematists; but it is far in advance of its predecessors, and the author of the present work was probably wise in following to so large an extent a system that has so many recommendations. In some minor points he has adopted evident improvements, as in the removal of *Volvox* from the Zygosporeæ to the Oosporeæ, in accordance with the recent observations of Cohn. He also removes Characeæ from Carposporeæ to Oosporeæ, which is perhaps better, if they are to be retained among Thallophytes. But will it be possible to do this? If a single criticism is admissible, we may append one which so often occurs in reading German books:—Why is there no index?

Anomalies in the Development of the Lowest Organisms.—Some researches lately made by W. Schmankewitsch, of Odessa,* on the development of fungus spores under changed external conditions, show the relation of certain colourless *Flagellata* on the one hand to *Fungi*, on the other to *Algæ*. The author's observations, if confirmed, will certainly tend to break down the distinction between these groups.

1. Spores of *Penicillium* were sown in a drop of filtered and boiled sea-water, the drop being placed on the under side of a cover slip serving as the roof of a small moist chamber. The chamber was exposed to sunlight, and the air in it was occasionally renewed, and was kept moist. The spores swelled up in the usual way prior to germination, but did not send out hyphæ. Their contents became sharply differentiated from the cell-wall, acquired a granular appearance and a distinct green colour, and developed a nucleus. The spores then divided like unicellular algæ, each into two daughter-cells.

2. Spores of *Aspergillus* were sown in the same way, in a drop of fresh water. A little distilled water was placed on the floor of the chamber, in a place darkened by a diaphragm, and in it was sown other spores of the fungus as generators of carbonic acid. The first drop of water was exposed to light from the concave mirror of the Microscope, and the air in the chamber was renewed weekly. After five weeks such spores as had not germinated, as well as the swollen cells of the hyphæ which others had sent out, had altered their appearance, their contents becoming green and granular, and sharply separated from the cell-wall, and afterwards dividing into four segments. The protoplasm also contained granules, which the author hints may be starch granules.

3. Some examples of a flagellate infusor (probably Bütschli's *Anisonema acinus*) were placed in a similarly disposed drop of fresh water. They soon ceased moving, and the secreted granules in their protoplasm (Secretkörnchen, Bütschli) began gradually to turn green, and many of them to increase in size, while some slowly made their way out of the body of the *Anisonema*. The latter, when full of these green granules, closely resembled the unicellular alga *Chlorococcum* during its multiplication by still gonidia. In the largest green granules a cell-wall could be distinguished. The author states that he has observed the converse of this case, namely, the trans-

* 'Zool. Anzeiger,' ii. (1879) 91

formation of the gonidia of *Chlorococcum* into colourless monads, and he considers that the "Secretkörnchen" of such flagellates as *Anisonema* are the homologues of the still gonidia of *Chlorococcum*. When the *Anisonemæ* were placed in the dark, the green granules became colourless, and then resembled ordinary fungus spores.

4. In a similar chamber colourless monads, probably undeveloped *Anisonemæ*, were observed to send out mycelial filaments, which afterwards broke up into short pieces; these subsequently assumed an oval form.

5. *Aspergillus* spores were sown, in water, on the bottom of a shallow chamber, and exposed to light. These spores became brighter and quite colourless; then, after three or four weeks their contents became granular, and a nucleus-like body appeared: the cell-wall at the same time became mucilaginous and the spores assumed an oval form. They then divided in the direction of their length into two parts. If the water evaporated somewhat, the spores elongated still more, becoming spindle-shaped; the division planes became more oblique, and, in each spore, a second division-plane appeared, intersecting the first, so that the two planes, as seen under the Microscope, crossed one another like the two arms of an X. The spores thus became divided into four elongated bodies, and thus closely resembled the alga *Scenedesmus*. Other spores became dark green in colour, and divided into four, like *Pandorina*.

6. *Aspergillus* spores, sown in water, became colourless, their cell-wall dissolved, and they became transformed into amœbiform masses, and then into true *Amœbæ* of light greenish colour. These *Amœbæ*, later, contracted into darker green spheres which divided, forming motile green bodies quite like the unicellular alga *Chlamydomonas*. In other cases the contents of the spores divided into colourless granules, the spores then resembling the cysts of certain monads.

The author concludes with some general observations on these very startling results.

Influence of Light on the Movements of Mobile Spores.—Along with the movements of mobile spores, caused by currents of water, which Sachs has succeeded in imitating by emulsions ('Flora,' 1876, Nos. 16–18), by which spores placed in water congregate near the edges of the vessel, and form the figures which Nägeli has shown, zoospores also possess, through their own innate force, a movement at once progressive and rotatory. Researches recently made by E. Stahl * have convinced him that the direction of the forward movement is determined by light, and is absolutely independent of the passive currents of water above mentioned.

The following are given by Stahl as the principal results of his researches, which he intends to amplify later.

Light exercises an influence on the forward movement of many mobile spores which have been called *heliotropic spores*. Other zoospores are absolutely indifferent to light.

The movement of heliotropic zoospores changes periodically in

* 'Bot. Zeit.,' xxxvi. (1878) 715.

direction, since the same individual sometimes directs itself towards the light, and sometimes away from it. In the movements here spoken of, the colourless portion which bears the cilia is always directed forwards. It depends on the power of the light whether the forward or the backward movement is the more rapid; if the light is feeble, the forward movement is almost always the most marked, and the contrary when the light is strong.

The final result will therefore be, that after some time, in the one case, the zoospore will approach the light, and in the other it will go away from it. The intensity of the light has moreover an influence on the ulterior movements, since mobile spores of the same species, which have attained the same phase of development, will behave differently under the same conditions of light, depending on whether they have been previously kept for some time in darkness, or on the contrary exposed to a strong light.

The sudden removal of the source of light which determines the direction of the movement of mobile spores is immediately shown by the abandonment of the direction previously followed; in many cases the forward movement ceases suddenly. This phenomenon is produced in both phases of the periodic movement, that is to say, in the individuals which are at the moment directed towards the light, and in those which are moving in the opposite direction.*

Entophytic and Entozoic (parasitic) Species of Cryptogams.— P. F. Reinsch contributes to the 'Botanische Zeitung,'† an account of the parasitic Algæ and Fungi which he has himself detected as growing within the tissues of animals and plants. Those hitherto observed as entozoic within the bodies of living animals belong to the lowest classes of Algæ and Fungi, viz. Phycochromaceæ, Oscillatorieæ, Leptothricheæ, Schizomycetes, and Hyphomycetes, and especially to the genera *Protococcus*, *Pleurococcus*, *Chroococcus*, *Sarcina*, *Vibrio*, *Spirillum*, and *Bacterium*. In addition to these he records the following:—

1. *A Floridea parasitic on Sponges and Bryozoa.*—This has been detected by M. Reinsch in the form of red threads, growing within the tubes of sponges and of *Sertularia pluma*, the latter itself growing on some of the large Fucaceæ of the Atlantic coast. The parasite enclosed within the thallus of the sponge forms elongated, usually but slightly branched threads, isolated or collected into bundles, penetrating the medullary and cortical substance of the sponge, never breaking through to the outside. No reproductive organs were detected. The parasite found within the tubes of Sertularia and Tubularia was different in form. It occurs as a weft of branching filaments covering the interior of the tubes, some of the filaments penetrating through the tissue of the tubes themselves. The reproductive organs occur in the form of tetrasporangia placed on short unicellular or bicellular pedicels, which were found only in the Sertularia and not in the Tubularia. These indicated a close affinity on the part of the parasite to Callithamnion.

* 'Rev. Internat. Sci.,' iii. (1879) 66.

† xxxvii. (1879) 17 and 33.

2. *A Chytridiacea parasitic on Florideæ.*—In the tissue of *Eucheuma isiformis* (from Key West) were observed cells of a different character from those of the tissue of the seaweed, and presenting the nearest resemblance to those of a Chytridium already known as a parasite on Desmidieæ.*

3. *Asterosphæriæ parasitic on Mesocarpus scalaris.*—These occur in the form of minute globular cells found in pairs within the cells of the Mesocarpus, one of each pair being usually smooth, and the other covered with spines. When the parasite is fully developed, the infected cell of the Mesocarpus is swollen into the form of a bladder, and all its protoplasmic contents have disappeared. The parasite probably enters in the form of a zoospore which pierces the cell-wall of the host, the orifice subsequently again closing up. The green colour of the infected cell gradually disappears as its protoplasm is absorbed by the parasite. Ultimately a kind of conjugation takes place between the smooth and spiny parasitic cells, the contents of the former passing into the latter. The ultimate fate of these latter is uncertain, and it is possible they may be merely stages in the development of some higher organism.

4. *Nostochaceæ and Oscillatorieæ in Gromia and in the Ova of Fresh-water Snails.*—An Oscillatoria is not uncommon within the siliceous carapace of Gromia, consisting of a coiled filament with a diameter of about 0·0084 mm. The two ends grow slowly, it is not enclosed in a gelatinous sheath, and is probably a Hypheothrix. In another species of Gromia a much coiled filament was observed completely filling its cavity, apparently a Cylindrospermum; it had abundance of chronospores. The ova of a small fresh-water snail found on the leaves of a Potanogeton, enclosed in a thin transparent calcareous shell, and about 0·13 mm. in diameter, were found to contain well-developed sporiferous filaments of a Spermosira; the spherical or elliptical spores, ·0056 mm. in diameter, were double that of the filament. The parasite had apparently developed after the escape of the young mollusc from the shell.

5. *Anabæna and Chlorococcum in the perforated Cells of Sphagnum.*—The green spherical cells of these two algæ were found in the large colourless empty cells of *Sphagnum latifolium* from Cape Cod. As the diameter of the smallest of them was double that of the perforations of the Sphagnum cells, they must have developed in that situation.

6. *Anabæna in the Leaf of Azolla canariensis.*—The hollow of the leaf of Azolla is, in at least one case out of three, filled with filaments of an Anabæna, which can only have penetrated from without through the open channel into the cavity.

7. *Oscillatoria parasitic in the Oogonium of Œdogonium.*—This is one of the most singular cases of parasitism. The specimen, apparently one of *Œdogonium Rothii*, had a well-developed, perfectly closed oogonium of normal structure, into which had penetrated a twice-coiled Oscillatoria-filament, probably a Hypheothrix. As the oogonium was perfectly closed, the parasite must apparently have

* Reinsch, in Pringsheim's 'Jahrb. f. wiss. Bot.,' xi. 18.

been nourished by its contents, which had completely disappeared, with the exception of a few mucilaginous particles.

8. *An intracellular Floridea parasitic on the Thallus of a Porphyra.*—On the margin of the thallus of *Porphyra vulgaris* (from Marblehead, Massachusetts Bay) were seen minute reddish specks formed by a peculiar parasite. Under a high power they were found to consist of a single cell of singular form with a number of branches radiating from its centre. The parasite had in these spots completely consumed the tissue of the host. Most of the radiating branches of the parasite were united in their growth with segmented bundles of cells running through the thallus of the host, which are metamorphosed cells of the Porphyra itself. The phenomenon presents the peculiarity that the parasitic cell has taken up in its growth, not the contents only but the cell-wall also of the infected cell. From this the author concludes, on physiological grounds, that the parasite cannot be a fungus, but must be a Floridea nearly related to Porphyra itself.

9. *Fungus-mycelium parasitic within the Hen's Egg.**—A hen's egg of ordinary size, and presenting nothing abnormal in the structure of the shell, skin, albumen, or yolk, showed, when held up to the light, small bright dots on the shell; the albumen and yolk were quite free from foreign bodies, and the shell was without any fungus-filaments, and showed no perforations under the Microscope. The parasite consisted of four hemispherical bodies with a diameter of from 4 to 4·5 mm., three of them of a greyish-brown colour, the other clear and nearly transparent. They were composed of a densely interwoven tissue of much-branched nearly transparent filaments, indistinguishable from the mycelium which is ordinarily formed after a time in an albuminous solution. The contents of the cell were quite clear, with a few large colourless granules. The author suggests that the spores must have entered the egg during its formation within the body of the bird.

10. *Dactylococcus De Baryanus and Hookeri.*—These parasitic algæ were first observed on small species of Copepoda (Cyclops and Lepidurus), where they occur in enormous quantities, appearing and again disappearing with great rapidity, and giving them a distinct green colour to the naked eye. The earliest condition of the parasite is that of a tolerably large motile cell, with amœba-like power of extension and contraction, between 0·02 and 0·03 mm. in diameter. The contents consist of green granules, among which is always one red one. When stretched to its full length, one end of the cell is free from granules, and at that end is a single rapidly vibratile cilium with club-shaped apex. After a short time the cells lose their motility, and then fix themselves to some part of one of the Entomostraca which are moving about among them. The point of attachment of the parasitic cell develops into a short clear pedicel, and the union with the body of the host becomes very close, and is effected with great rapidity. It does not appear, however, to have any injurious effect upon the host. In the female *Cyclops bicaudatus* the ovary in the last segment of the

* See also this Journal, ii. (1879) 315.

abdomen is always free from the parasite. The further development has been observed in both German and American examples, and consists of a separation of the contents in the largest diameter of the cell, and the formation of three or more daughter-cells; but the origin of the amœba-like cells has not yet been observed.

Cryptogamia Vascularia.

Germination of the Schizæaceæ.—This interesting and singular family of Ferns has been made a subject of careful investigation by Bauke,* as far as concerns the structure of the prothallium and its development from the spore; his observations having been made chiefly on *Aneimia Phyllitidis*, *collina*, and *cheilanthoides*, and *Mohria caffrorum*. The following is a summary of his conclusions:—

1. In all the genera examined, Schizæa, Lygodium, Aneimia, and Mohria, the spores are of a tetrahedral form.

2. In Aneimia and Mohria, the exospore is invariably furnished with characteristic ridges, which are either smooth or covered with conical protuberances.

3. The germination of the spore of Aneimia and Mohria does not differ essentially from that of the Polypodiaceæ and Cyatheaceæ, except that the filament which is the first result of germination develops into the plate of cells which constitutes the prothallium, by the formation of longitudinal walls by the other cells of the filament, at the same time that this takes place in the apical cell, or even earlier.

4. The apical cell of the filament divides longitudinally into two more or less unequal segments. One of these becomes a plate of cells increasing by marginal growth. The other, usually the larger one, is either distinctly marked as a wedge-shaped apical cell (Mohria), in which septa arise inclined alternately to the right and left; or (Aneimia) several parallel septa are formed at right angles to the first division-wall, commencing from below upwards. Even where there was a distinct apical cell, it was not observed to become segmented more than three times.

5. In the first segment-cell of the apical cell formed in the last-named manner, there is usually produced, after a time, a marginal cell of characteristic form, which grows in the direction parallel to the margin of the prothallium, and becomes divided by transverse septa. This is the origin of the "cushion" of the prothallium.

6. Independently of this lateral row of cells, which ultimately becomes the cushion, the plate of cells increases by ordinary marginal growth, advancing in a direction at right angles to the margin. This proceeds actively, so that ultimately the lateral row of cells is removed to a considerable distance from the base of the prothallium.

7. At the time of the formation of the cushion, the form of the prothallium is, in Aneimia, more or less distinctly reniform, the lateral row of cells lying always on the concave side; in Mohria it is at first broadly spathulate, ultimately roundish.

8. In Mohria, and sometimes in Aneimia, the cells of the lateral

* Pringsheim's 'Jahrb. f. wiss. Bot.,' xi. (1878) 603.

row also divide. The innermost of the cells thus formed, together with the adjoining cells of the flat portion, then further divide by walls parallel to the plane of the latter, and thus form the cushion. The marginal cells of the original row become, in Aneimia, the "apical edge" of the cushion, growing in a direction at right angles to the margin, but maintaining their narrow form. In Mohria no such apical edge is formed.

9. Both in Aneimia and Mohria the cushion is formed at the side of the prothallium, rarely, in the former genus, at its apex.

10. A common characteristic of the prothallium of both genera is the occurrence of papillæ; in Aneimia only on the margin, and curved towards the apical edge of the cushion; in *Mohria caffrorum*, on the contrary, almost exclusively on the surface of the prothallium. The first papilla is always formed in close proximity to the lateral row of cells.

11. The rhizoids make their appearance on the oldest cells of the germinal filament, and next most abundantly on the lower margin of the prothallium, and especially on the same side as the row of cells already mentioned. Subsequently, as in other cases, they spread over the lower surface of the cushion.

12. The antheridia are distinguished, in both genera, by the formation of a bell-shaped membrane when the central cell is separated from the wall. The "stigmatic" or covering cell appears to be always thrown off in *Mohria caffrorum*, while in Aneimia it is ruptured in the form of a star. The first antheridia are produced in both genera, like the rhizoids, on the margin below the lateral row of cells, spreading thence to the surface of the cushion.

13. The construction of the archegonia offers no striking peculiarity. In Aneimia the neck was usually found straight; in Mohria, curved towards the base of the prothallium.

14. From the time when the cushion is formed, the divisions parallel to the surface of the prothallium continue in a backward direction; while the part which takes no share in the formation of the cushion continues its marginal growth, and in Aneimia becomes more and more arched upwards.

15. In those prothallia of Aneimia where, from deficiency of antherozoids or any other cause, fertilization is not effected, the cushion always projects laterally in the form of an outgrowth of usually nearly uniform breadth, and continues to grow at the apical edge until either fertilization takes place or the prothallium perishes.

16. Under certain unfavourable conditions the production of archegonia on the cushion ceases, the cushion continuing its growth; and its lower side then becomes covered instead with antheridia; thus showing that the continued growth of the cushion need not necessarily result in the formation of archegonia.

17. While in the Polypodiaceæ and Cyatheaceæ there are not usually any adventitious shoots on the normally cordate prothallium, such shoots are almost invariably formed, in both Aneimia and Mohria, on the cushion of older prothallia, originating in cells belonging to the flat portion.

Fungi.

Relationship of Oidium albicans and Mycoderma vini. — The relationship to one another of the various forms of the fungi known as Schizomycetes which cause or accompany the phenomenon of fermentation has been much debated. In an article in Virchow's 'Archiv' * Grawitz concluded, from Cienkowski's descriptions and figures, the identity of the "Soor-pilz," *Oidium albicans*, or *Saccharomyces albicans*, with the "Kahmpilz," variously known as *Mycoderma vini*, *Mycoderma cerevisiæ*, *Saccharomyces Mycoderma*, *Hormiscium vini*, and *Hormiscium cerevisiæ*. In the 'Sitzungsbericht der phys.-med. Soc. zu Erlangen,' 1878, Reess now contests this view, and maintains the complete distinctness of the species. The two ferments can, he states, be cultivated side by side under precisely similar conditions of nutrition, supply of air, temperature, &c., without one of them passing over into the other. The Mycoderma can be cultivated in cherry-juice or in a strongly acid aqueous solution of ammonium acetate with a little yeast and solution of cigar-ash; even when agitated daily, the cells and groups of cells never assume the forms which Oidium would take under similar conditions. In the same manner cultures of Oidium in solution, well supplied with nutriment and with air, can be kept for as much as six weeks without any development of Mycoderma taking place; the surface of the fluid remains clear. The masses of Oidium consist mostly of roundish cells formed in much-branched groups, mixed with which are less often to be found short filaments which bud at the septa. These are not to be confounded with the filaments of Mycoderma produced in similar circumstances. Reess gives a detailed account of the series of experiments on which he relies for the establishment of the position laid down above.†

Alcoholic Fermentation. — M. P. Miguel ‡ has made some experiments which confirm M. Pasteur's views on fermentation. When the must of grapes, which has been sterilized, is exposed to the air in September, in vineyards in the south of France, and put in vessels free from germs, it generally begins to ferment after a few days. This is due, he considers, to gnats, who carry through the air the yeast of the vine, attached to their proboscis and to different parts of their bodies. If the must is preserved, boiled and clean, from the insects, at the same time permitting the air to circulate freely with its numerous microbia, the must most often becomes mouldy and does not ferment.

This fact shows therefore that *all* the cases of spontaneous alcoholic fermentation cannot be attributed to the organized "dust" of the air; on the other hand, experiments prove that air in motion does carry the alcoholic yeast. It was found to abound in the vineyards, whilst at Paris not a single case of spontaneous alcoholic fermentation could be obtained. In Paris also it is not difficult to obtain microbia exactly resembling the alcoholic yeasts. In some attempts at sowing these organisms, introduced into the sterilized

* lxx. (1877) Part 4. † 'Hedwigia,' xvii. (1878) 56.
‡ 'Comptes Rendus,' lxxxvii. (1878) 759.

must with the spores of mould which accompanied them, fermentation did not result, and we may therefore suppose either that they belong to Cryptogams whose physiological functions differ from those of the alcoholic yeasts, or that their germination may be hindered by the rapid development of the moulds. In the course of the experiments several cases were observed of fermentation suspended by the excessive growth of microphytes.

Experimental Researches on a Leptothrix found during life in the blood of a woman suffering from a severe (and mortal) attack of puerperal fever.—A note on this subject by M. V. Feltz, is to be found in the 'Comptes Rendus.'* Two days before death a number of transparent, immobile filaments, which were simple or jointed, straight or curved, were found in the blood of the patient; they were ·003 to ·006 mm. long, and ·0005 to ·0003 mm. broad; they differed from the Leptothrix found in the mouth in the absence of the mobile spores from which the latter are developed. While they are destroyed by putrefaction, they increase in great quantities when introduced into the blood of the living animal. The state thus induced is marked by an incubation period of varying length, and a diseased stage, in which there is a slight rise in temperature, and an affection of the mucous membranes, and difficulty of respiration, terminating in death by asphyxia. Post-mortem examination reveals the presence of an enormous quantity of immobile rods, by which the small vessels may be obliterated. Multiplication is most rapid in the rabbit. Small, and even infinitesimal doses produce the same effects, but successive inoculations do not, as in septicœmia, increase the virulence of the attack. The poisonous matter does not dialyse, and neither desiccation nor cooling has any effect on it. Solutions containing the poisonous body may be rendered innocuous by filtration in vacuo through thick layers of charcoal. When cultivated in alkaline urine, the development of the rods from ovoid spores may be followed out; the rods become granular and break up under the action of alcohol or the prolonged action of carbonic acid, as well as by heating to 130° or 140°.

The Leptothrix of the gums does not produce any toxic effect on the blood of the rabbit, and the form now under description appears to be inoffensive to the dog.

Sexuality of the Ascomycetes.—The Italian cryptogamist Borzi, in accordance with the views of De Bary, Woronin, Janczewski, and others, but in opposition to those of Tulasne, maintains† the existence of a sexual mode of reproduction in these fungi. He confirms the view of previous observers that the sexual organs are to be found on the scolecite, a mycelial branch so called in consequence of its vermiform shape, at present known only in the Discomycetes. Janczewski has already described this organ in five species, *Ascobolus pulcherrimus*, *A. furfuraceus*, *A. carneus*, *A. saccharinus*, and *A. pilosus*; to which Borzi now adds five more, viz. *A. immersus*, *A. œrugineus*, *Saccobolus violascens*, *Ascophanus granuliformis*,

* lxxxviii. (1879) 610. † 'Giorn. Bot. Ital.,' x. (1878) 43.

and *Byparobius*, sp. n. Borzi describes the scolecite of *Ascobolus pilosus* as composed of three parts. The first consists of the apical cell only, which is hemispherical, and contains a transparent protoplasm. The second part also consists of a single cell, termed the ascogenous cell or ascogonium, which is of about double the diameter, and nearly spherical; its protoplasmic contents are much more granular. The third and lowest part of the scolecite is composed of a row of from four to seven much smaller cells, gradually decreasing in size towards the base; they also contain a finely granular protoplasm. From the hyphæ which surround the base of the scolecite springs a single branch which runs obliquely up the scolecite, and, at about two-thirds of its height, i. e. near the base of the ascogonium, branches. To this body, which does not differ morphologically from the other cells of the hymenium, but to which a fertilizing agency has been attributed by De Bary, the term pollinodium has been applied. Borzi, however, disputes this interpretation, and considers that the organ in question has no function but one of protection to the scolecite. The ascus ultimately develops from the ascogonium, the first indication being presented by the appearance on its surface of a number of minute papillæ. These gradually elongate and divide transversely into short filaments; the terminal cells of some of these filaments acquire a club-like form, and are the young asci. The ascogonium, and indeed the whole scolecite, then disappears. That the ascus and ascospores are the result of a process of fecundation, Borzi was unable actually to determine, though he has little doubt that this is the case. His own view is that the male organs of fecundation are the spermatic cells of minute size produced on special hyphal branches in the neighbourhood of the scolecite, and this last organ he looks on as a carpogonium, the terminal cell being a trichogyne, through which the fecundating particles are conveyed to the ascogonium; the lower multicellular portion of the scolecite being simply a support for the female sexual organ. The apothecium of Ascobolus Borzi considers to consist of three parts:—the cortical layer, which involves the whole apothecium except the upper part; the excipulum, the cells of which, uniform in size, compose a pseudo-parenchymatous tissue; and the hymenium, consisting of the asci, and of paraphyses, elongated barren filaments, ramifying at the base. The asci spring from the lower or sub-hymenial portion of the hymenium. They have at first the form of club-shaped cells containing abundance of protoplasm; the ascospores are formed in them by free cell-formation. The ejection of the spores is the result of the constantly increasing pressure of the hymenium on the mature asci. In addition to the ascospores, *Ascobolus pulcherrimus* produces another kind of germinating cell, the chlamydospores, produced probably non-sexually, at the apex of short mycelial filaments. In several species of Peziza, Borzi claims to have observed phenomena altogether similar to those of Ascobolus.

Polymorphism of Agaricus melleus.—In his researches on the chestnut-tree disease,* J. E. Planchon was struck with the difficulty

* This Journal, ii. (1879) 167.

of determining the species of Agaricus, the mycelium of which is the cause of the disease. In a note read before the French Academy,* he now identifies it as *Agaricus melleus* Vahl, of which he considers *A. griseofuscus* DC., and *A. Mori* Fr., to be mere varieties. The mycelium of this fungus, known to older authors as *Rhizomorpha fragilis*, attacks the roots of a variety of trees, as the mulberry, chestnut, horse-chestnut, lilac, apple, and vine. This mycelium occurs in three different forms—(1) filamentous or byssoid, which has been seen to proceed directly from the spore, and which attacks especially the root of the vine; (2) radiciform or rhizomorphic (*Rhizomorpha fragilis subterranea* of authors), smooth and brown, with tufts of red filaments, comparable to the sclerotia of other fungi; and (3) membranaceous or hymenoid (*Rhizomorpha fragilis corticalis*), which penetrates in the form of flat expansions, between the layers of the bark, into the cambium zone, and even into the wood itself.

Conidia of Fistulina hepatica.—As long ago as 1864, Seynes described certain spore-like bodies which he found on the upper surface of the receptacle of this fungus; and the observation was confirmed by Léveillé, Thuret, and Bornet. G. Arcangeli has submitted these bodies to a fresh examination,† and confirms in all important points the observations of Seynes. The conidial region of the receptacle is easily recognized by its more intensely red colour. The conidia are oval or ellipsoidal, varying in length from 0·006 to 0·01 mm., and in breadth from 0·004 to ·005 mm.; and they are borne, in larger or smaller numbers, on delicate conidiophores, the whole being of a tawny colour. Arcangeli has no doubt that these conidia belong to the Fistulina itself, and not to another fungus parasitic upon it. He considers that the presence of these organs indicates a transition from the Polyporei to the Gasteromycetes which are furnished with more than one kind of reproductive organs.

Algæ.

Morphology and Biology of the Phycochromaceæ. — Professor Borzi,‡ of Vallombrosa, has worked out a classification of one of the lowest and least studied groups of chlorophyll-containing Thallophytes, the Phycochromaceæ (known to some writers as Phycochromophyceæ), called by Cohn Schizophyta, to correspond with the analogous Schizomycetes of the non-chlorophyll-containing Thallophytes. This group he classifies as follows:—

Ord. I. NEMATOGENÆ Rabh. Cells united into linear filaments.

Sub-ord. 1. **Hormogeneæ** Thr. (*Nostochineæ* pl. auct.). Multiplication by means of hormogonia (mobile fragments of filaments).

Fam. 1. *Nostochaceæ* Rabh. Filaments of cells vermiform, simple, usually interrupted by heterocysts; increase indeterminate; spores.

* 'Comptes Rendus,' lxxxviii. (1879) 65.
† 'Nuov. Giorn. Bot. Ital.,' x. (1878) 369. ‡ Ibid., 236.

Fam. 2. *Scytonemaceæ* Borz. (*Scytonemeæ* Thr., *Scytonemaceæ* and *Sirosiphonaceæ* Rabh.). Filaments filiform, simple, or more often branched, interrupted by heterocysts; increase apical and indefinite: spores.

Fam. 3. *Rivulariaceæ* Rabh. (*Calotricheæ* Thr.). Filaments filiform, simple or branched, often with heterocysts; increase apical and limited; spores.

Fam. 4. *Oscillariaceæ* Rabh. ex part. (*Lyngbyæ* Thr.). Filaments filiform, simple, without heterocysts; increase indefinite; no spores.

Sub-ord. 2. **Cystogoneæ** Borz. Multiplication by means of isolated, immobile, vegetative cells.

Fam. 5. *Chamæsiphonaceæ* Borz. Filaments filiform, simple; increase apical, indefinite; no heterocysts; spores (?).

Ord. II. GLŒOGENÆ Cohn. Cells distinct, either isolated or collected into larger or smaller families.

Fam. 6. *Chroococcaceæ* Rabh. ex part. Cells multiplying by indefinite bipartition in three directions, at all events at the moment when the colonies are first formed; spores.

The paper referred to contains an exhaustive account of the biology and morphology of the first of these families, the *Nostochaceæ*, under which Borzi includes the following genera:—*Nostoc* Vauch., *Anabæna* Kütz., *Isocystis* Borz., *Sphærozyga* Rlfs., *Cylindrospermum* Rlfs., *Nodularia* Mart., and *Aphanizomenon* Morr.

In a subsequent paper in 'Flora,'* Sig. Borzi makes some further remarks on his proposed new genus Isocystis, of which he gives the following character:—Filaments solitary, a larger or smaller number irregularly and more or less densely interwoven into an indefinitely extended layer, never united in parallel growth, often very delicate and perceptibly narrowed at the apices; cells elliptical or spherical, sometimes oblong-quadrate from mutual compression, sometimes angular or disk-shaped, closely connected or distinct; spores, where known, globose, sub-globose, or oval, of a bluish-olive or dusky golden colour; exospore thin or moderately thick, very smooth or scabrous. The typical species is very similar in external appearance to an Anabæna, but is distinguished by the invariable absence of heterocysts, and by the tendency of the filaments to unite into small bundles, like those of Aphanizomenon. The genus includes four species, three of them now described for the first time, the fourth previously regarded as an Anabæna (*A. infusionum*). They represent the simplest and lowest type of the Nostochaceæ, scarcely ever forming colonies of any considerable size. The very delicate moniliform filaments are found floating on the surface of the water, either solitary or in interwoven masses; the mucilage which envelops them is very small in quantity, and disappears completely at a very early period. Borzi considers

* 'Flora,' xxxvi. (1878) 465.

the genus of considerable importance from a systematic point of view, as exhibiting a clear affinity with the lower forms of the Schizomycetes, especially the Bacteria.

Halosphæra, a new Genus of Unicellular Algæ (Plate XVI.).—Dr. F. Schmitz gives an extremely interesting description of a new form of unicellular marine algæ, under the name *Halosphæra viridis*.*

It presents the appearance of minute green points just visible to the naked eye, the largest being a little more than half a millimetre in diameter, floating on the surface of the water in the Bay of Naples, and long known under the designation "punti verdi." It is to be found regularly in the spring from the middle of January to the middle of April, when it disappears. The light green globule, which has no independent power of motion, is enclosed in a tolerably thick, smooth, and perfectly colourless membrane; the inside of this membrane is clothed with a thin layer of protoplasm, enclosing a single very large central vacuole with colourless cell-sap. Imbedded in the protoplasmic layer are a small number of minute chlorophyll-grains, and a single globular nucleus with a somewhat darker nucleolus.

The process of cell-division which takes place during the development of this alga is very interesting, and altogether in accordance, in all essential points, with that described by Strasburger in his 'Zellbildung und Zelltheilung' as occurring in the tissue of more highly organized plants. As the cell increases in size, the nucleus divides into two, which gradually separate from one another, and again undergo division (Fig. 1); and, as this process is repeated many times, a very large number of nuclei, from 200 to 300, come to be tolerably regularly dispersed throughout the protoplasm of the mother-cell. The mother-cell has now attained its full size, and the division of its contents into daughter-cells commences, the protoplasmic layer gradually collecting around the nuclei, so that each becomes the centre of a new primordial cell (Fig. 2). This process takes place slowly, so that its various stages can be closely followed. The space between the daughter-cells appears to be occupied only by a colourless cell-fluid; the cells having the form of hemispherical balls in close contact with the inner membrane. They are of a bright green colour, but no separate chlorophyll-grains are to be detected in them. These become the mother-cells of the zoospores. The outer membrane of the entire cell has in the meantime become differentiated into two distinct layers, of which the outer one now bursts by a nearly circular slit, and slips off the inner membrane, which now itself clearly consists of two layers. This layer next begins to swell up and deliquesce, and at length becomes resolved into mucilage. As soon as this change commences, the hemispherical green daughter-cells begin gradually to detach themselves from the outer membrane, and to distribute themselves over the interior of the cell (Figs. 3, 4, 6). Each of them usually divides into two zoospores, though sometimes a larger number, and sometimes only one, are developed from each daughter-cell (Figs. 7–15). In the ordinary case the green primordial cell first of all contracts in the

* 'Mittheil. Zool. Station Neapel,' i. (1878) 67.

middle into an hour-glass shape, and then divides in the centre into two bodies of conical shape, each with a nearly flat but toothed base and a pointed apex. To a colourless elevation in the centre of the nearly flat base are attached two long vibratile cilia; the zoospores thus differing considerably in form from any known elsewhere. Various stages of this process are to be observed at one time within the external membrane of the same mother-cell, which is now gradually deliquescing, so that the zoospores are set free into the surrounding water, where they move about for a time with a comparatively slow motion, and then fall to the bottom. Their further development Dr. Schmitz has been unable to follow.

With regard to the systematic position of *Halosphæra*, notwithstanding its external resemblance to *Volvox*, its internal structure forbids its location among Volvocineæ. It bears more resemblance to De Bary's genus of Conjugatæ *Eremosphæra;* but until its life-history is more completely known, its genetic affinities must remain in obscurity.

Plate XVI. Fig. 1.—Single cell of *Halosphæra viridis;* the nucleus has formed a great number of nuclei by repeated bipartition.

Fig. 2.—The same. The parietal layer of protoplasm has collected round the very numerous nuclei into flatly hemispherical masses.

Fig. 3.—The same. The outer cell-wall layer has burst after the daughter-cells have been completely formed; the inner layer has stretched considerably; within it the daughter-cells have become separated from the cell-wall.

Fig. 4.—Formation of the daughter-cells. The thin parietal layer of protoplasm between the separate hemispherical masses of protoplasm is beginning to separate; a number of cavities have already made their appearance in it.

Fig. 5.—Abnormal formation of two daughter-cells, whose nuclei have nearly coalesced.

Fig. 6.—Daughter-cells immediately after the division of the mother-cell, still in close contact with the cell-wall.

Figs. 7–9.—Division of the daughter-cells in the formation of zoospores.

Figs. 10, 11.—Zoospores. Fig. 10 in optical longitudinal section.

Fig. 12.—Division of a daughter-cell into four zoospores.

Figs. 13–15.—Abnormal formations. Two (Fig. 15), five (Fig. 13), and twelve (Fig. 14) zoospores are formed by incomplete division from a single daughter-cell; they have become completely separated from one another.

(Figs. 1–3 × 100; Figs. 4–11 × 300; Figs. 12–15 × cir. 150.)

Black Mildew of Walls.—Professor Leidy, at a meeting of the Philadelphia Academy of Natural Science, referred to an article in 'Hardwicke's Science-Gossip' for August by Professor Paley, entitled "Is the Blackness on St. Paul's merely the effect of Smoke?" According to the author, the blackness is mainly due to the growth of a hitherto undescribed lichen which appears to flourish on limestone, and in situations unaffected by the direct rays of the sun. Professor Leidy

said that his attention had been called a number of years ago to a similar black appearance on the brick walls and granite work of houses in narrow shaded streets, especially in the vicinity of the Delaware river. Noticing a similar blackness on the bricks above the windows of a brewery, from which there was a constant escape of watery vapour, in a more central portion of the city, he was led to expect that it was of a vegetable nature. On examination, the black mildew proved to be an alga closely allied to what he supposed to be the *Protococcus viridis*, which gives the bright green colour to the trunks of trees, fences, and walls, mostly on the more shady and northern side. It probably may be the same plant in a different state, but, until proved to be so, may be distinguished by the name of *Protococcus lugubris*. It consists of minute round or oval cells, from 0·006 to 0·009 mm. in diameter, isolated or in pairs, or in groups of four, the result of division; or it occurs in short irregular chains of four or more cells up to a dozen, occasionally with a lateral offset of two or more cells. By transmitted light the cells appear of a brownish or olive-brownish hue. In mass, to the naked eye, the alga appears as an intensely black powder.*

MICROSCOPY.

Employment of Wet Collodion for Microscopic Sections.—M. Mathias Duval points out † the difficulty of finding any body which would firmly hold delicate objects, in which there are a large amount of hollows and cavities, such, for example, as embryonic tissues; it is obvious that the best substance would be one, which though solid is not friable, and which at the same time is homogeneous; these conditions are not satisfied by the ordinary imbedding mixtures, such as gelatine, wax and oil, or soapy bodies; one that has been largely used is gum solidified by the action of alcohol, and this has been recommended by Dr. Klein; in the directions appended to their 'Treatise on Embryology' (of the Chick), Foster and Balfour expressly state that they do not recommend it for the study with which they are there particularly engaged, nor does the experience of other embryologists seem to do otherwise than confirm their opinion. Nor, again, do the methods ordinarily in use allow of the advantages which would be gained by the use of a transparent imbedding substance.

Already used in its *dry* state for certain observations, collodion has been found to have much to recommend it, but it is too hard for delicate bodies; when, however, a small quantity is treated with alcohol at 36°, it is found to retain its volume, while presenting a large amount of consistency, elasticity, or transparency. Having used the substance for six months, M. Duval now feels justified in recommending it to the attention of students; the embryos to be examined are first hardened by osmic acid, alcohol, or some other method, are stained with carmine, and then placed in alcohol; they are placed for a few minutes in ether, and are then removed to the liquid collodion, in which they remain for a period varying from

* 'Proc. Acad. Nat. Sci. Phila.' (1878) p. 331.
† 'Journ. Anat. et Phys.' (Robin), xv. (1879) 183.

ten minutes to twenty-four hours. When withdrawn from this, they have attached to them a piece of elder-pith, or are, if their size and state permit of their being cut without any such aid, thrown at once into alcohol; the body now becomes surrounded with an elastic mass of collodion, which solidifies without alteration of volume, and encloses the pith if this has been already added. Thus treated, the tissue is ready for immediate section, or may be kept in alcohol for an indefinite period without danger.

As the sections are made in the ordinary way, that is, the body itself and the razor being both wetted with alcohol, it is obvious that the collodion will be prevented from becoming dry; there is no need to remove the imbedding substance, and the section may be immediately placed on a slide; a drop of glycerine and a cover-glass are then all that is necessary for the observer to find himself delighted with an object, the optical properties of whose imbedding substance are exactly the same as those of glass. Another advantage remains to be noted, the collodion has not in M. Duval's sections lost its transparency after a period of six months.

A similar method may be used for fœtal cerebral structures, and in the study of the eye or of the cochlea and similar delicate parts.

Method of Preserving the more delicate and perishable Animal Tissues.—In a valuable article* on the development of the earthworm, *Lumbricus trapezoides* Dugès, M. Kleinenberg says that whilst a great part of the earliest formations of the egg can be made out in the living state, the protoplasm being sufficiently transparent to allow the internal parts to be seen, yet afterwards the precise outlines of the cells disappear, and nothing can be seen but the grosser structure. To make out the more delicate structure it is necessary to employ reagents.

Osmic acid applied in the state of vapour gives good results; but the preparations obtained by the use of a mixture of picric with sulphuric acid are more satisfactory. It has, however, the same drawback as osmic acid, of occasionally producing swellings in the primitive blastomeres, which, if it only slightly alters the normal conditions, renders the preparations less sightly. This difficulty is overcome by the addition of a little kreosote.

M. Kleinenberg, however, after many experiments, recommends strongly the following method of preservation, which he used for the particular researches treated of, and for the majority of other animal tissues, especially for the more delicate and perishable.

Prepare a saturated solution of picric acid in distilled water, and to a hundred volumes of this add two volumes of concentrated sulphuric acid; all the picric acid which is precipitated must be removed by filtration. One volume of the liquid obtained in this manner is to be diluted with three volumes of water, and, finally, as much pure kreosote must be added as will mix.

The object to be preserved should remain in this liquid for three, four, or more hours; then transferred, in order to harden it and

* 'Quart. Journ. Micr. Sci.,' xix. (1879) 206.

remove the acid, into 70 per cent. alcohol, where it is to remain five or six hours. From this it is to be removed into 90 per cent. alcohol, which is to be changed until the yellow tint has either disappeared or greatly diminished. Alcohol of 90 per cent. is better than absolute for preserving the more delicate structures for a long time uninjured, and for keeping the preparation at the proper degree of hardness.

For colouring, crystallized hæmatoxylin is to be used, dissolved in the following mixture:—Prepare a saturated solution of calcium chloride in 70 per cent. alcohol, with the addition of a little alum; after having filtered, mix a volume of this with from six to eight volumes of 70 per cent. alcohol. At the time of using the liquid pour into it as many drops of a concentrated solution of hæmatoxylin in absolute alcohol as are sufficient to give the required colour to the preparation of greater or less intensity, according to desire.

This mixture, notwithstanding its chemical irrationality, gives good results. Aqueous solutions, especially when they contain traces of ammonia, are to be avoided, since they are very hurtful to many delicate tissues. The object must remain in the dye for a period varying from a few minutes to six hours, according to its size and to the nature of the tissues composing it. It is a good rule, when intending to make sections, to stain deeply and to cut them *very thin*.

When removed from the dye the preparation is to be washed in 90 per cent. alcohol, in which it may remain from six to twelve hours. Finally, to remove every trace of water, it should remain for half or a whole day in absolute alcohol.

If the preparation is to be cut it must be removed from absolute alcohol to essential oil of bergamot, in which it should remain for some hours, in order to fit it for being imbedded in paraffin, which is removed from the sections when cut by means of a mixture of four parts of essence of turpentine with one part of kreosote. Finally, the sections are mounted in resin dissolved in essence of turpentine.

Histologists are warned not to use a solution of resin in alcohol. The preparations mounted in this are at first beautiful but soon become spoiled, in consequence of the precipitation of crystals or of an amorphous substance. He lost in this manner many hundreds of preparations, and the same results have occurred in the Zoological Station at Naples.

Preparation and Preservation of the Lower Organisms.—M. Raphaël Blanchard, of Paris, referring to the process employed by Koch to preserve and photograph Bacteria,* says † that more than two years ago, he preserved Bacteria in lasting preparations by using with excellent results osmic acid instead of the process of desiccation employed by Koch, which he considers a very bad one.

In a few hours, or two days at the longest, the surface of water in which an organized substance (vegetable or animal tissue, &c.), has been macerated, becomes, as is well known, covered with a slight

* See this Journal, i. 195. † 'Rev. Internat. Sci.,' iii. (1879) 245.

pellicle composed of a more or less compact mass of Bacteria, enveloped in a hyaline, transparent substance of slight consistence. This membrane is so fragile that the slightest movement or breath which ripples the surface of the water tears it. A tolerably large piece of this membrane can be obtained by carefully introducing into the liquid beneath it a glass slide, and raising it with caution.

If we then add, with a pipette, one or two drops of a concentrated solution of osmic acid (or even a solution of 1 in 100) to the membrane on the slide, it immediately acquires a much greater consistency and can be covered without fear of tearing it. A drop of a solution of violet of methylaniline should be placed at the side of the cover-glass, drawing away the osmic acid by a cigarette paper on the opposite side. In about half an hour the Bacteria assume a fine violet tint, the fundamental substance remaining colourless; if the impregnation lasts longer the Bacteria assume a deeper hue, and the fundamental substance becomes tinted. We can then replace the violet of methylaniline by glycerine, which does not render the preparation colourless, as Koch says, if we add a small quantity of the violet. A concentrated solution of sulphate of calcium can also be used with advantage to preserve the preparations. M. Blanchard's collection contains preparations made thus in 1876, which are as bright in colour as at first.

The violet is not the only aniline colour which can be used, but it seems to be more durable than others.

A solution of hæmatoxylin can also be used with advantage. When a "proliferous membrane" (F. A. Pouchet) has been treated with osmic acid, it is left for twenty-four hours under a damp bell-glass, in a watch-glass containing a few drops of hæmatoxylin. There is then formed an iridescence which spoils the clearness of the preparation, but which can be easily removed by repeated washings. The membrane is then mounted in glycerine (with or without the addition of hæmatoxylin), or in a solution of chloride of calcium, and preserves indefinitely a fine violet tint.

If the Bacteria are free in the liquid, the process of mounting them would be exactly the same.

To prepare Infusoria, or any of the lower organisms, osmic acid should be used, but in a strong or even concentrated solution which instantly kills the animalculæ. A group of Vorticella thus fixed will retain their natural form, some of them being completely extended and others more or less retracted. Amœbæ, Rhizopoda, &c., have no time to retract their protoplasmic filaments, and die spread out on the glass in their living aspect.

Ciliated Infusoria do not lose their cilia, and except a slight blackish hue they are in no way modified by the reagent. Some Opalinæ found more than a year ago in the intestine of a Triton have preserved to this day the delicate cilia with which their body is covered.

The contact of the osmic acid must not be prolonged, or the objects will blacken with age. After the animalculæ are covered with the thin glass, a few drops of picro-carmine or hæmatoxylin can be added.

The picro-carmine does not sensibly colour Bacteria, but it colours very clearly the nuclear formations contained in the bodies of the Infusoria. After the colouring glycerine can be added, and the preparation is complete.

In the study of the lower vegetable forms with naked protoplasm, Myxomycetes, for instance, osmic acid and picro-carmine and hæmatoxylin can be equally well used. By the action of osmic acid the currents in the protoplasm of the Myxomycetes are instantly suspended, and in a few instants the protoplasm is sufficiently hardened to make sections possible.

There are certain exceptional cases in which osmic acid has no direct action. A Nematode, for instance, *Anguillula aceti*, can live a long time in a liquid containing osmic acid. In the case of a female the eggs develop and hatch, and the embryos grow at the expense of the mother, until nothing remains of her body but the outer cuticle, which resists all attacks of the acid. When the young Anguillulæ have pierced the cuticle and are free, they swim apparently unharmed by the acid, though they generally die in a few days.

A similar example is furnished by the larvæ of the Diptera, *Chironomus plumosus* Linn., which lives in water strongly mixed with osmic acid, owing to its cuticle resisting the acid.

Another Method of Preserving Bacteria, &c.—"T. C.," in 'Science-Gossip,'* says that he has experimented upon a method for obtaining permanent preparations of Bacteria, Vibriones, &c., and after some years of patient research has found the following excellent method:—The requisites are a bottle of thin Canada balsam diluted with chloroform, a hot-water plate, and the fixing solution, which consists of 25 cc. of chromic oxidichloride acid to which is added 50 cc. of water with 50 cc. permanganate of potash. A ring of white wax, much larger than the cover-glass, is drawn on the slide, within which the organisms are placed with some water. When they have attached themselves to the slide, some of the solution is added, which will instantly fix the specimen. After three minutes the water may be poured out, and a few drops of chloroform added and poured off, the cover-glass placed carefully on, and a few drops of dilute Canada balsam added, so as to flow under the cover, and the preparations placed on the hot-water plate to dry. Thus prepared they retain all the features of the living animal.

Mounting Noctiluca miliaris.—Some *Noctilucæ* having been collected last summer in Beaumaris Bay, Mr. J. E. Lord says † that he and Dr. Worrall tried mounting them in shallow cells, with various preservative media to compare the results. Balsam, glycerine, fresh and sea-water, glycerine jelly, Dean's medium, and several others were tried. One or two of the slides rapidly deteriorated, others held out for a longer period, but the specimens mounted in sea-water retained all their features to this date (not specified). As the animals retain their shape, it would appear that there has been no endosmose or exosmose action going on..

* 'Sci.-Gossip,' 1879, No. 173, p. 111. † Ibid., p. 113.

Searching for Trichinæ.—Mr. George W. Morehouse, of Wayland, N.Y., says * that it is undeniable that microscopists waste a good deal of valuable time by the use of higher powers than are necessary, and by imperfect preparation of objects for examination. In nothing is this more forcibly illustrated than in the examination of pork for trichinæ. For this purpose it is customary to use powers of 75 diameters and upwards (seldom as low as 50), and the meat is not always made sufficiently transparent for ready detection of the parasites. A power of 25 diameters, obtained with a good 2-inch objective, and 2-inch ocular, is amply sufficient. With the 2-inch we have greater depth of focus, the object is still shown with great clearness, and, most important of all, we are able to do as much searching in one hour as it would take about nine hours to accomplish with a $\frac{2}{3}$-inch objective.

As to preparing pork for present, rapid, and accurate observation, he has found the following method to work well:—Cut thin longitudinal sections from the extremities of muscles, and from other favourite localities where the worms, in migrating, stop in greatest abundance, and place the sections in a watch-glass, covering them with acetic acid. In a few minutes the tissues will be transparent enough to enable one to see the letters through the specimens when the watch-glass is placed on a printed page. Drain off the acid, add water and examine, or wash and transfer to a glass slip (large, with large cover, for a number of sections at once), either in water or glycerine, and cover. For permanent preservation, while the sections are still in glycerine, press them for several days between plates of glass, and mount at leisure in pure glycerine. When thus prepared, the parasites remain coloured more highly than the surrounding muscular fibres, and readily attract the eye. They are so plain, that none, when brought into the field of view, can escape instant detection. The process is simple, takes but little time, and is inexpensive.

Method of Studying the Structure of Vegetable Matter.—M. Merget, of Bordeaux, finding that mercurial vapour easily permeates disks of wood, recommends it as a means for studying the structure of vegetable matter. If wood, after exposure to the vapours of mercury, is brought in contact with a sensitive paper (obtained by saturating paper with an ammoniacal solution of nitrate of silver) a distinct design of the fibro-vascular bundles and of the medullary rays will be obtained. We may thus design the stomata of a leaf, and show that in the case of those possessing stomata on both surfaces the air circulates from one epidermis to the other.†

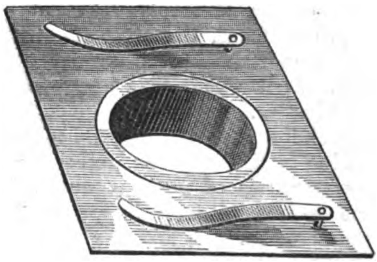
Thin Stages.—It is, we think, a matter for surprise that with all the attempts that have been made to produce stages of excessive thinness, to allow of the use of light of extreme obliquity, opticians have never provided their Microscopes with any contrivance for allowing the slide to be attached to the under side of the stage. Such a contrivance would cost a very trifling sum, and by its adoption the

* 'Am. Journ. Micr.,' iv. (1879) 36.

† 'M. Journ. Sci.,' i. (1879) 389.

utmost possible limits of obliquity would be attained. This is the more important at the present time, when the apertures of object-glasses are being so largely increased.

Contrivance for holding Objects beneath the Stage.—Since the preceding note was in type the 'Monthly Journal of Science' has published * a note on a simple contrivance for holding the object beneath the stage of the Microscope when extreme obliquity of illumination is required. It is the device of Mr. John Phin, of New York,



and has the advantage of being easily adapted to any Microscope. The little "sub-stage" (shown in the annexed woodcut) with clips attached slides into the aperture in the stage, and the mode of use is obvious. Mr. Phin states that the plan of holding the object beneath the stage is not new, having been invented by Mr. C. S. Spencer about twenty years ago.

New Microtome.—Several years ago, wishing to make some thin sections of animal tissue, and not having the educated hand, Dr. S. W. Fletcher, of Pepperell, Mass.,† set about devising an instrument for doing such work. The conditions to be fulfilled appeared to him to be: to attach the cutting blade to a carrier so arranged as to draw repeatedly the edge of the blade over the specimen with any desired inclination and in exactly the same course; to prevent every part of the blade, except the edge actually cutting, from touching the preparation; to immerse the object in alcohol or other preservative fluid whilst being cut; and to approach the specimen to the blade to any desired extent, the whole instrument being made heavy and firm enough to prevent any considerable trembling under ordinary use. These conditions he has endeavoured to fulfil in the following manner:—

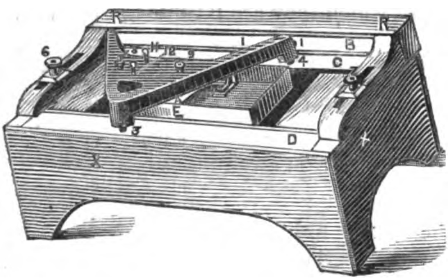
X X, Fig. 1, is a wooden frame 16 inches in length, 8 inches in width, and 5½ in height; to the top of this is clamped the wooden bar R R by means of the bolts 6 and 7, which pass through the slots cut in the arms which project from each end of it. B is a piece of thick plate-glass cemented to the side of the bar R R, and C and D are similar pieces of glass cemented to the top of the frame X X. In the centre of

* 'M. Journ. Sci.,' i. (1879) 392.

† 'English Mechanic,' xxix. (1879) 108 (from 'Boston Medical and Surgical Journal').

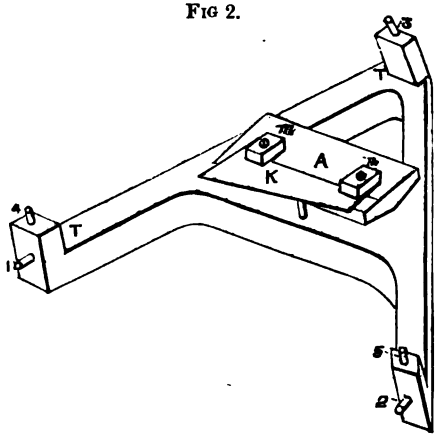
the frame is the brass pan E. Near the centre of this pan is a well, 1 inch in diameter and 2 inches deep. At one side of the well is a clamp, 4, which by the screw 1 is pressed tightly against the specimen to be cut. Over this pan is the iron tripod T T (see Fig. 2), beneath which is suspended a brass plate A by means of the bolts 8 and 9.

FIG. 1.



This plate is made to incline more or less towards the glass plate C, and is fastened firmly in position by the set screws 11 and 12. By these any desired inclination can be given to the cutting blade, which is clamped to the under surface of the plate A. He commonly used a wide Le Coulter razor blade for cutting. The legs of the tripod have ivory pins driven firmly into holes drilled deep in their ends; these

FIG 2.



pins project one-fourth of an inch, and their points, 3, 4, 5, rest on the glass plates C and D. From the sides of two of the legs ivory pins project in the same way, and their points, 1 and 2, rest against the glass B. The opposite sides of the well are grooved on their outer surfaces, and in these grooves rest brass guide-pieces, which are firmly bolted to the frame X X, and connected with these guide-pieces is a screw, the point of which presses against the lower part

of the bottom of the well. The threads of this screw are forty-eight to the inch, and the circumference of its head is divided into fifty equal parts.

Fig. 2 represents the tripod seen from below, showing the ivory points 1, 2, 3, 4, 5, the brass plate A, and the blade K fastened by the clamps *m* and *n*.

Fig. 3 shows the shape of the heads of the bolts 8 and 9, Fig. 1, and the manner in which they are let into the plate A.

FIG. 4.

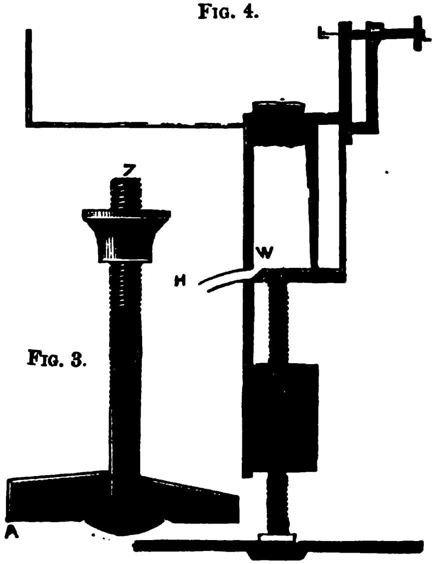


FIG. 3.

Fig. 4 represents a section through the pan, showing the arrangement of the well W, clamp L, and screw for raising the pan. H is a rubber tube, leading from the bottom of the well, for drawing off the alcohol in the pan after using the instrument.

FIG. 5.

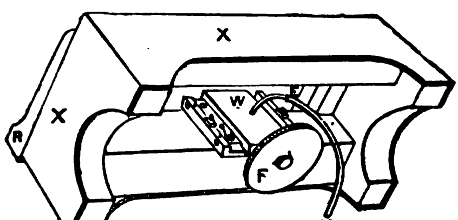


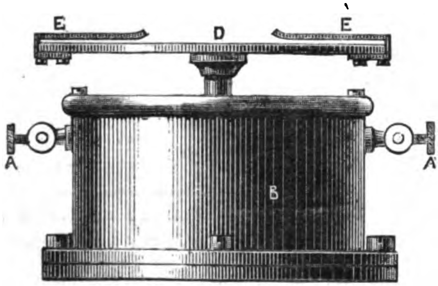
Fig. 5 represents the frame X X seen from below, showing the pan, well W, screw F, rubber tube H, and brass guide-pieces, and the manner in which they are attached to the frame.

The ivory points being well oiled, fill the pan with alcohol, so as to cover the top of the specimen O; place the tripod over the pan, and as far to the left as possible; turn up the screw F until the top of the object to be cut reaches the blade; push the tripod forward from left to right, and the blade will shave the top of the preparation; draw the tripod from the glass B for half an inch, or raise the leg of the tripod resting on D half an inch; it can then be pushed to the end of the glass plates from which it started without the knife touching at any point. Now let the tripod approach the glass B until the points 1 and 2 touch the glass; turn the screw F so as to elevate the pan more or less, according to the desired thickness of the section; again repeat the moving of the tripod as already described, and a section is obtained of uniform thickness and any desired thinness the blade is capable of cutting. With a well hardened specimen and a very thin, sharp blade, sections three-fourths of an inch wide, 1 inch long, and 1-2400th part of an inch thick can readily be made. Very delicate objects need to be imbedded in wax or paraffin; ordinary ones are held by the clamp L without any such preparation.

The whole instrument weighs about 16 lbs., and costs about twenty-five dollars, not including the blades. The cost of four or five blades is not far from five dollars, or one dollar each.

Electrical Mounting Table.—Mr. F. M. Rogers, of Moorgate Station Buildings, E.C., communicates the following:—Microscopists who mount their own objects must have felt the want of a mounting table that would automatically run at any desired rate of speed, while allowing the mounter free use of both his hands. The instrument represented in the woodcuts, which has been devised by him, supplies these requirements, the motive power being electricity, derived preferably from a small and very inexpensive bichromate battery.

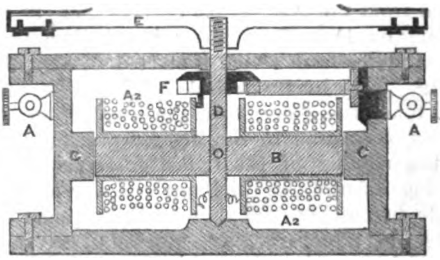
FIG. 6.



Upon joining up the two connecting wires from the battery to the terminals marked A, Figs. 6 and 7, a current flows through the insulated wire A^2 surrounding the bar of soft iron B, which is pivoted to the spindle D, and carries the table E. The bar is thus rendered powerfully magnetic, and instantly turns towards the top of the nearest inclined armature, of which there are six, C^2 (Fig. 8), cast

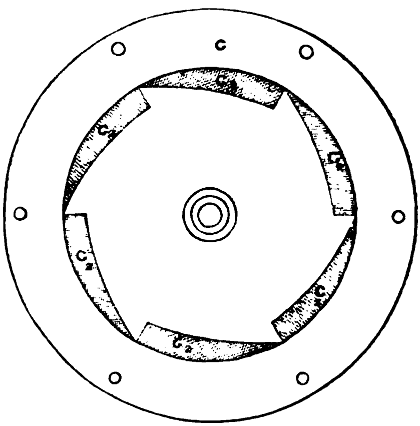
in the case C. By means of a circular contact-breaker F, Fig. 7, fixed to the spindle D, but insulated from it, the current is only allowed to excite the magnet when its poles are at the foot of any of

FIG. 7.



the inclined armatures; as it turns towards the top, or point nearest its poles, the current ceases, and with it any retarding action upon the magnet. Acquired momentum carries it to the foot of the next

FIG. 8.



incline, and the process is repeated, a steady rotary motion resulting, which can be regulated by exposing more or less of the zinc in the battery to chemical action.

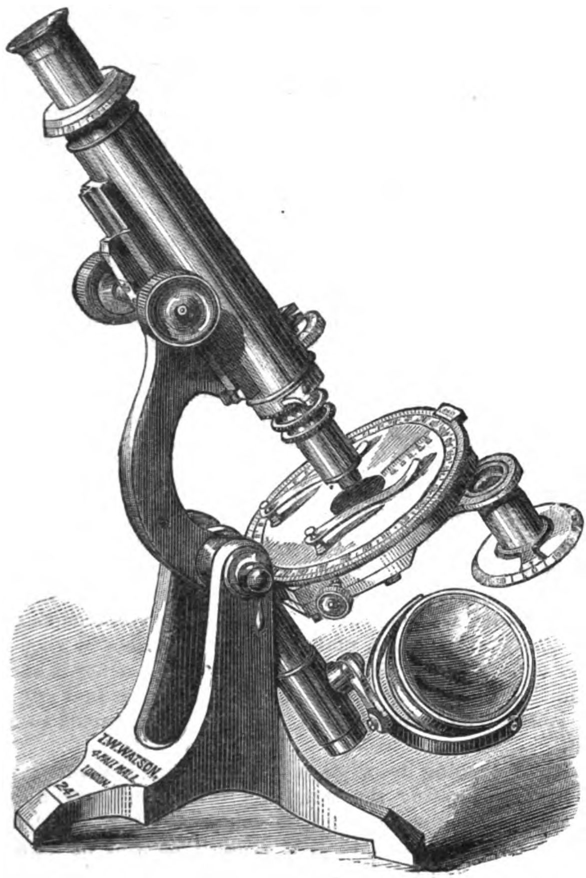
English Microscope for Students of Mineralogy and Petrology. —Mr. Frank Rutley describes * a new Microscope, specially suited for mineralogical and petrological research, constructed for him by Mr. T. W. Watson, of Pall Mall.

An examination of one of the Microscopes devised by Professor Rosenbusch and manufactured by Fuess, of Berlin, showed that, although that instrument possessed many features of great merit, it

* 'Nature,' xx. (1879) 13.

also had certain defects which could be best overcome by adopting and modifying a good English model.

The great defects in most of the Microscopes built on the continental patterns consist in their fixed vertical position, the smallness of their stages, and, very commonly, in the absence of any means of coarse adjustment, except by a sliding movement of the body or tube, which, if working stiffly, is very inconvenient, while, if sliding easily, it is apt to be shifted by a very slight touch.



The instrument now manufactured by Mr. Watson is in most respects quite equal in performance to Rosenbusch's, so far as the mechanical appliances and adjustments are concerned, and is, in point of convenience, decidedly superior to the latter instrument.

The general form of the instrument is sufficiently shown in the accompanying woodcut. In the stand first made the milled head of

the fine adjustment was divided for the measurement of the thickness of sections, but in future it is proposed to effect this object in a different manner by divisions engraved upon the limb and the sliding portion of the coarse adjustment (a vernier). The right trunnion carries a clamp to fix the instrument at any angle. The head of the tube or body carries a bevelled disk which is divided to 10° spaces. A corresponding disk with an index is attached to the bottom of the analyzer-fitting, and rests directly upon the fixed divided disk; so that the analyzer can be set in any required position, and any amount of revolution imparted to it can also be registered. The eye-piece, when inserted, is kept in a fixed position by a stud, which falls into a small slot. Crossed cobwebs are fixed within the eye-piece for the purpose of centering the instrument. A small plate of calc-spar, cut at right angles to the optical axis, is mounted in a little metal ring, which can be placed between the eye-glass and the analyzer for stauroscopic examinations.

At the lower end of the Microscope-tube a slot is cut to receive a Klein's quartz plate or a quarter-undulation plate, both of which are set in small brass mounts. When these are not in use the aperture can be closed by means of a revolving collar.

The stage is circular, and capable of concentric rotation, and it is divided on the margin to 360°. A vernier is attached to the front of the stage, giving readings to one minute. The edge of the stage is milled, and rotation is imparted by hand.

The polarizer slides into a fitting which is fixed to an arm pivoted on the lower, movable surface of the stage, so that it can readily be displaced when ordinary transmitted illumination is required, and replaced with equal facility.

Two little lenses, affording a strongly-convergent pencil of light, are set in metal rings which drop into the top of the fitting which surrounds the polarizing prism. When these are employed and the analyzer is used, without lenses in the eye-piece (a separate fitting is supplied for this purpose), examinations of the rings and brushes presented by sections of certain crystals, can be advantageously carried on, and a quarter-undulation plate can also be employed when needful. The lower end of the fitting which carries the polarizer is surrounded by a divided disk, turning beneath a fixed index, so that any position of the prism can be recorded, and the rotation imparted to it can be measured.

From the foregoing description it will be seen that this instrument is capable of performing the functions of an ordinary Microscope, a polariscope, a stauroscope, and, to some extent, a goniometer. A spectroscope could be fitted to it if needful, as well as an apparatus for heating sections of crystals.

Female Microscopical Society.—We gather from a report of a "regular meeting" of the Microscopical Society of Wellesley College, U.S., on March 15, reported in the 'American Journal of Microscopy,'* that it consists exclusively of lady members. The

* 'Am. Journ. Micr.,' iv. (1879) 71.

President, Miss Cook, was in the chair. Miss Dickinson read a paper upon animal and vegetable hairs, which was illustrated by slides of horizontal sections of the scalp prepared by Miss Nunn, Professor of Biology; Miss Beattie presented a paper on Bacteria; Miss Whipple gave a demonstration of the method of cutting and double staining vegetable sections, beginning by describing the proper method of honing a razor; slides mounted by Misses Cummings and Whipple were exhibited; Miss Whiting called attention to the receipt of fifty of Smith's slides of Diatomaceæ; and, finally, the report is attested by "Marion Metcalf, Corresponding Secretary."

Oblique Illumination.—Mr. C. Hue says that he has obtained highly successful results where extreme obliquity of illumination is required, by the use of the parabolic illuminator, in conjunction with a small super-stage, similar to that of Dr. Matthews.

Limits of Accuracy in Measurements with the Microscope.—Professor Rogers calls attention to the note on p. 345 of vol. i., and says that the error referred to consists in the report from which we quoted having given 32 millionths instead of 32 ten-millionths.

Royal Society Conversazione.—On April 30th, at the above Conversazione, the following were the exhibits relating to microscopy:—

Messrs. Powell and Lealand:—Their new $\frac{1}{8}$ oil-immersion lens, with *P. angulatum.*

Mr. F. Ward:—New micro-spectroscope, in which a rectangular quartz prism is substituted for the usual metallic slit. (This Journal, vol. i. p. 326.)

Mr. J. Mayall, jun.:—Zeiss's new $\frac{1}{18}$ oil-immersion lens, with *Amphipleura pellucida* (in balsam); and the improved immersion illuminator designed by the exhibitor with special reference to the Ross-Zentmayer stand.

Mr. Crisp:—Powell and Lealand's new $\frac{1}{8}$ oil-immersion lens, with *Frustulia Saxonica* (dry), and a similar illuminator.

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Hitchcock, R.—Micrometry. *Am. Q. Micr. Jour.*, I., No. 3.

Hyde, H. C.—Presidential Annual Address to the San Francisco Microscopical Society. *Am. Journ. Micr.*, IV., No. 3.

Malassez, L.—Correction of the Distortions produced by the Camera Lucida of Milne-Edwards and of Nachet. (3 figs.) *Trav. Lab. Histol. Coll. France*, 1877–8.

„ „ Note on the Measurement of Microscopic Amplifications. (1 fig.) *Trav. Lab. Histol. Coll. France*, 1877-8.

Mayall, J., jun.—Immersion Illuminators for the Microscope. [Translation of paper read before the Brighton and Sussex Natural History Society.] *Journ. de Micr.*, III., No. 4.

Pelletan, Dr. J.—New Laboratory Microscope. *Journ. de Micr.*, III., No. 4.

Rogers, Prof. W. A.—On Two Forms of Comparators for Measures of Length. (1 fig.) *Am. Q. Micr. Journ.*, I., No. 3.

Rotating Clips for Cheap Microscopes. (1 fig.) *Am. Journ. Micr.*, IV., No. 4.

Roy, C. S.—A New Microtome. (1 fig.) *Journ. Phys.* (*Foster*). II., No. 1.

Rutley, F.—An English Microscope for the use of Students of Mineralogy and Petrology. (1 fig.) [See this Journal, II., p. 471]. *Nature*, XX., No. 496.

Simple Contrivance for holding the Object beneath the Stage of the Microscope. (1 fig.) *M. Journ. Sci.*, I., No. 65.

Smith, Prof. H. L.—A few Remarks on Angular Aperture, and Description of a "Universal Apertometer." (1 plate.) *Am. Q. Micr. Journ.*, I., No. 3.

Sub-stage for Oblique Light. (1 fig.) *Am. Journ. Micr.*, IV., No. 4.

Tolles, R. B.—Clear Working Distance. (2 figs.) *Journ. de Micr.*, III., No. 4.

Vorce, C. M.—The Mechanical Finger. (1 fig.) *Am. Journ. Micr.*, IV., No. 3.

Ward, Dr. R. H.—On a Standard for Micrometry. *Am. Nat.*, XIII., No. 5.

Wenham, F. H.—On the Formation of the Paraboloid as an Illuminator for the Microscope. (3 figs.) *Am. Q. Micr. Journ.*, I., No. 3.

Williams, W. M.—Spiders' Webs for Micrometers. (From 'Journal of the Society of Arts.') *Am. Journ. Micr.*, IV., No. 4.

PROCEEDINGS OF THE SOCIETY.

MEETING OF 14TH MAY, 1879, AT KING'S COLLEGE, STRAND, W.C.
THE PRESIDENT (DR. BEALE, F.R.S.) IN THE CHAIR.

The President on taking the Chair congratulated the Fellows upon having obtained possession of their new room and upon the appearance it presented. They were very much indebted to the Library Committee for the successful manner in which they had arranged the room, and it was also satisfactory to know that this had been effected out of revenue, and without diminishing the capital account of the Society.

The thanks of the Society were, on the motion of the President, voted to the Library Committee.

The Minutes of the meeting of 9th April were read.

Mr. Michael said that though Mr. Stephenson's motion included a declaration that the $\frac{1}{100}$ of a millimetre was too large a standard, he and others who voted upon it understood that a suggestion of Dr. Edmunds had been adopted, and that the latter part of the motion only was intended to be put to the Meeting.

Mr. Ingpen confirmed this, and

The President, with the assent of the Meeting, erased the first part of the motion (leaving it to stand, "That in the opinion of this Society it is not expedient at present to prescribe by any formal resolution the adoption of a fixed standard for micrometry"), and the minutes were so confirmed and signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted and the thanks of the Society given to the donors, viz.:—

	From
Burgess, E.—The Anatomy of the Head and the Structure of the Maxilla in the Psocidæ. (Reprinted from the 'Proceedings of the Boston Society of Natural History.' Vol. xix. 1878)	*The Author.*
'Index Medicus: a Monthly Classified Record of the Current Medical Literature of the World.' Compiled under the supervision of Dr. J. S. Billings and Dr. R. Fletcher. Vol. i. Nos. 1, 2, and 3 (January, February, and March.) 4to. New York, 1879	*The Editor.*
Trübner, N.—'Bibliographical Guide to American Literature.' 8vo. London, 1859	*Mr. Crisp.*
12 Slides of Insects from Nevis, West Indies	*Dr. J. Borell.*
2 Slides of Lung of Sheffield Saw-grinder	*Mr. A. C. Cole.*
15 Photographs of Blood-corpuscles of Man and Animals ..	*Dr. J. B. Treadwell.*
3 Carved Wood Chairs for the President and Secretaries ..	*Mr. Crisp.*

The President, in reading the names of further Societies recommended by the Council under the bye-law as to Ex-officio Fellows, said

that the Council had been much gratified at the extremely cordial manner in which the Societies previously nominated had received the nominations. Two of them had done him the honour to elect him an Honorary Fellow.

Photographs (15) of blood, sent by Dr. J. B. Treadwell, of Boston, U.S. (through Mr. C. Stodder), were shown, and the following letter from Mr. Stodder read:—

"Dr. Treadwell's object is the measurement of the blood-disks and comparison of size of human blood with that of other animals, and the focussing is so done as to show the sharpest outline of the diameter. I will call the especial attention of the Society to those photographs on which there are two kinds of blood—blood from two animals. Several devices have been used by others to accomplish this object, one of much importance for obtaining in a picture the exact amplification for both kinds of blood, and which, I believe, has not been so successfully before accomplished. I trust that these will be acceptable to the Society. The mounting of the slides and the photographing is all done by Dr. Treadwell."

Mr. A. W. Waters' paper "On the occurrence of recent Heteropora" (see p. 390), was read by Mr. Stewart, who also described by drawings on the black-board the slide of *Membranipora membranacea* brought by Mr. Dreyfus.

Mr. John Davis's paper on "A new species of Cothurnia" was read by Mr. Stewart, and the drawings enlarged on the board.

Mr. Wenham's "Note on Homogeneous Immersion Object-Glasses" was read by Mr. Crisp (see p. 394):—

"From a paper contributed by me to the 'Monthly Microscopical Journal,' June 1st, 1870, I quote the following comments in favour of 'Homogeneous Immersion.' 'One advantage in the immersion objective is that it almost prevents the loss of light from the reflection of the upper surface of the cover and front of lens, and in part neutralizes any error of figure and polish that may exist between them. There is also another condition annexed, it has the singular property of a *front lens of adjustable thickness*, and therefore can be set to the utmost nicety to balance the observations. Of course there is no optical advantage attendant upon the use of *water*. If a medium of the same refractive power as the glass were to be employed, the result would be better. Water having a low refractive index, an adjustment is required for each thickness of cover, and a difference of adjustment is not so marked and sensitive as in the ordinary dry objectives; but if a medium of similar refraction to the glass were to be used, no adjustment would be required for any thickness of cover, supposing the test objects to be mounted thereon (which they generally are), for in fact we should then view them all with a front of the same

thickness—considering the cover, the front lens, and the interposing medium as one.'"

Mr. Stephenson being absent from town the following note from him was read by Mr. Crisp.

"I have read Mr. Wenham's note containing a reference to his paper of 1870, of which, however, I was not aware when I brought the subject of Homogeneous Immersion before the Society in 1878.

"I do not understand what it is that Mr. Wenham claims.

"The use of oil instead of water was suggested by Amici prior to 1850; and it is equally clear that it was not until 1878 that any homogeneous immersion objectives were produced in a practical form, and then it was by Professor Abbe and Mr. Zeiss, and more recently by Messrs. Powell and Lealand.

"As, during a great part of the period between 1870 and 1878, Mr. Wenham has been actively engaged in the construction of immersion object-glasses, it is evident that he did not appreciate the practical advantages likely to follow from the introduction of oil-immersion glasses any more than Amici and other previous experimenters on the subject did.

"This is not surprising when it is remembered that the *very essence* of the homogeneous system depends under Professor Abbe's able development on an optical principle which Mr. Wenham has for many years contended, and still contends, to be a physical impossibility, viz. it gives an angle greatly in excess of even the ideal maximum of a dry lens (180°).*

"Moreover, if Mr. Wenham had attempted to give practical effect to his suggestion of 1870 he would have found that identity of refractive index between the cover-glass and immersion fluid was by no means consistent with optical homogeneity, one of the most essential conditions of which is identity of dispersion."

Mr. Wenham said that it had not been his intention to raise any controversy, but simply to record what he had done. If Amici had given a distinct description of it he did not, of course, want to claim it.

Mr. Crisp said, that he thought it must be considered beyond dispute that Amici was the first to suggest and to use oil as an immersion fluid for objectives, in which he was followed by Oberhäuser, Harting, and others. They all apparently thought, however, that oil-immersion objectives, were not capable of practical application. He read the following extract from M. Robin's book:—

"We have seen that the principal obstacle to good resolution arises from the violent refraction which the rays undergo on leaving the cover-glass and passing into air, and again on their second refraction by the front lens. Amici thought that to correct this defect the front lens should form part of the cover-glass, but how could the distance of the object from the lens be made variable? Simply by interposing between them an elastic medium having nearly the same refractive index as the glass. He suggested that the lens

* See 'M. M. J.,' v. pp. 16–17 and 118; vi. pp. 84–86 and 292; vii. p. 272; xi. p. 113; xii. p. 222; xiii. p. 35, &c.

should be plunged in a liquid of the same index as the cover-glass, glycerine mixed with oil of aniseed, for instance, or even the latter alone; later he recognized that distilled water corrected very well the feeble aberrations produced by the differences in the relative thickness of the media, glass and water. . . . The experiments of Amici on immersion objectives date from 1844. I saw in that year, or the following one, at Oberhäuser's, an objective with which he showed the advantages [of the immersion system] by interposing between it and a preparation of *Lepisma* scales either a drop of neats' foot oil or a drop of essential oil. He considered them to be preferable to water, the employment of which he had already recommended as giving good results with all kinds of objectives of short focus." *

Mr. Woodall called attention to the passage in Professor Abbe's paper (see p. 256), in which he referred to Mr. Stephenson's suggestion, that homogeneous immersion objectives would allow of increased angular aperture, which suggestion led to the making of the objectives.

Mr. Ingpen thought they must all regret that Mr. Wenham had not followed up his experiments in homogeneous immersion. Had he done so, we probably should have long since had the oil-immersion objective as an English instead of a foreign production. The refractive index of the immersion fluid employed was not the only consideration—the selection of an oil of suitable *dispersive* power had been made by Professor Abbe, after many experiments. Moreover, it must be remembered that the great advantage of the oil lens was its increased angle and consequent augmented resolving power, which was not originally contemplated as a result of homogeneous immersion. In the case of the new lenses they had not merely the results of a series of experiments, but also their successful practical application in the construction of improved objectives.

Mr. Wenham wished to say one word as to the medium. At the time referred to he had used oil of cloves. He did not care to make any oil lenses then because he had a wholesome fear of it. If the fingers were smeared with it and the instrument then touched, it took off the lacquer, besides unsetting the cement and destroying the objects.

Mr. Hue's suggestion for the more convenient use of oil with homogeneous immersion objectives was explained by Mr. Crisp, viz. to screw over the front of the objective a small receptacle contain-

* Prof. Ch. Robin, 'Traité du Microscope.' Paris, 1871. Pp. 191–192.

Prof. Harting, in his work on the Microscope, thus referred to the use of oil:—

"If we could replace the layer of water by a fluid of still greater refractive power, such as oil, further advantages must obviously be obtained. This has been successfully tried. It seems to me, however, a great risk to bring costly objectives in contact with an oily fluid which would have to be again removed by alcohol and ether. This would be hazardous with double lenses cemented with Canada balsam. The immersion system has, it is true, been so arranged that the front lens is not a double, but a single one of crown glass, and for these immersion in oil would certainly be much less objectionable. Nevertheless, I must doubt whether the oil-immersion system can ever come into more general use."—P. Harting, 'Das Mikroskop' (2nd German edition). Brunswick, 1866.

ing the oil, having capillary holes in a ring round the front lens, so that by screwing it up or down the oil would be forced out or drawn back again.

Mr. Crisp said that he should have stated at the meeting of 12th March last that the immersion illuminator, consisting of a hemispherical lens with movable setting (see p. 223), was the design of Mr. J. Mayall, jun., and was specially applicable to the Ross-Zentmayer stand.

Mr. Watson exhibited Mr. Frank Rutley's petrological Microscope (see p. 471), and the exhibition of Mr. J. M. Rogers' electrical mounting-table was, at his request, postponed until the next meeting, in consequence of his absence from England (see p. 469).

The President reminded the Meeting of the Scientific Evening on the 21st inst., and said that if any Fellows wished to measure the aperture of their objectives by Abbe's apertometer, Mr. Mayall would have the apparatus at the meeting, and be prepared to do so.

The following were exhibited:—

Mr. A. C. Cole:—2 sections of lung of a Sheffield saw-grinder who died from the effects of his work, the lung being the typical specimen on which the late Dr. J. C. Hall founded his successful agitation for improved workshops.

Mr. Dreyfus:—*Membranipora membranacea* (Polyzoon).

Mr. C. Hue:—Parabolic illuminator and super-stage (see p. 473).

Dr. J. B. Treadwell:—15 photographs of blood-corpuscles.

Mr. F. H. Ward:—Section of leaf of misteltoe, stained.

Mr. Watson:—Rutley's Petrological Microscope (see p. 471).

Mr. Crisp:—(1) Various microtomes: (*a*) the Rivet microtome (in wood); (*b*) Schiefferdecker's microtome ('Q. Journ. Micr. Sci.,' vol. xvii. 1877, p. 35); (*c*) Walmsley's adaptation of Bevan Lewis's ether-spray microtome; (*d*) Army Medical Museum (U.S.) pattern microtome. (2) Spawn of perch, showing embryo and peculiar radial pin-shaped striæ in the albumen (from Mr. Bolton). (3) *Melicerta tubicolaria* (Hudson) (*M. Troy*), described by Dr. Hudson in 'M. M. J.,' November, 1875, which Mr. Bolton had now found again in another locality.

New Fellows:—The following were elected *Fellows*:—Messrs. J. F. Hepburn, A. R. Kirby, W. R. Makins, F. Oxley, and J. H. Puleston, M.P.

WALTER W. REEVES,
Assist.-Secretary.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST, 1879.

(*From the 'American Naturalist,' July* 1879.)

Royal Microscopical Society.—With an evident desire to share its prosperity with others, this Society is renewing and extending its efforts to make itself a centre of influence in the cultivation of microscopical science throughout the world.

Its Journal, under the honorary editorship of one of the Secretaries of the Society, has become a superb magazine of microscopical science.

By a recent action of the Society, fifteen Honorary Fellows were elected, including Dr. J. Leidy, of Philadelphia. Nearly seventy societies, in different parts of the world, were also designated, whose Presidents for the time being should be Ex-officio Fellows of the Society. As this arrangement includes the honorary distribution of the Journal, it is a very generous as well as very judicious action.

EXPLANATION OF PLATE XVII.

Fig. 1.—*Alectona Millari*, n. sp. Longitudinal section of branch of coral of *Amphihelia oculata*, Dune, showing:—*a a*, excavated portion occupied by the Sponge; *b*, cribriform papilla; *c c*, minute processes.

Fig. 2.—The same. Cribriform papilla, more magnified.
" 3.— " Skeleton-spicules.
" 4.— " Subskeleton-spicules.
" 5.— " Varieties of subskeleton-spicules.
" 6.— " Flesh-spicules.
" 7.— " Larger variety of flesh-spicules.

* Vol. i. pl. xi.

ing the oil, having capillary holes in a ring round the front lens, so that by screwing it up or down the oil would be forced out or drawn back again.

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At the concluding meeting of the Session in June, the President, in wishing the Fellows a pleasant vacation, said that they might all congratulate themselves upon the present position of the Society. Many improvements had recently been carried out; their finances were in an exceptionally favourable state, the capital account having been increased, and the revenue for the present year being no less than 200*l.* in excess of that of last year; they had acquired the use of the excellent room in which they were assembled, and they had had nearly fifty applications for Ordinary Fellowship, which was an unprecedented increase in so short a time.

[illegible] described by Dr. Hudson in 'M. M. J.,' November, 1875, which Mr. Bolton had now found again in another locality.

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WALTER W. REEVES,
Assist.-Secretary.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST, 1879.

TRANSACTIONS OF THE SOCIETY.

XXVI.—*On a New Species of Excavating Sponge (Alectona Millari); and on a New Species of Rhaphidotheca (R. affinis).*

By H. J. Carter, F.R.S., &c.

(*Read* 11*th June*, 1879.)

Plates XVII. and XVIIa, Figs. 1-4.

At the request of Dr. Millar I undertake the description of these sponges respectively, prefacing the former with his own observations, which are as follows:—

"In the month of May last, while looking for sponges on a piece of *Amphihelia oculata* given to me by Dr. Duncan, I noticed on it numerous small, cribrate, flattish papillæ, of a pale pinkish colour, slightly raised above the surface, which, when detached and examined microscopically, were found to be almost entirely composed of spicules so like those of a *Gorgonia* that, until tried with acid, I could not be convinced of their siliceous composition. Seeking for the form of the largest ones in the late Dr. Bowerbank's 'Monograph of the British Spongiadæ,' I found them to correspond with the spicule figured in No. 245,* which Dr. Bowerbank believed 'to belong to a sponge not yet identified.'

"Having in vain attempted to extricate one of these papillæ

EXPLANATION OF PLATE XVII.

Fig. 1.—*Alectona Millari*, n. sp. Longitudinal section of branch of coral of *Amphihelia oculata*, Dunc, showing:—*a a*, excavated portion occupied by the Sponge; *b*, cribriform papilla; *c c*, minute processes.

Fig. 2.—The same. Cribriform papilla, more magnified.
„ 3.— „ Skeleton-spicules.
„ 4.— „ Subskeleton-spicules.
„ 5.— „ Varieties of subskeleton-spicules.
„ 6.— „ Flesh-spicules.
„ 7.— „ Larger variety of flesh-spicules.

* Vol. i. pl. xi.

by mechanical means, I subjected a portion of the coral bearing one to the influence of acid, when the papilla above mentioned was not only eliminated in a perfect state, but numerous brown points made their appearance at various depths from the surface of the coral, which, as the latter became entirely dissolved by the acid, were, together with the cribrate papilla, found to be processes of membranous, cellular sarcode, presenting a brown colour (in its dried state), which lined the centre of the coral, now reduced by excavation from solidity to a mere shell in many parts. These 'processes' which were conical and thus engaged in excavating the coral, might also, on reaching the surface, grow into the form of cribriform papillæ if necessary.

"As the sponge appears to be nearly allied to *Gummina Wallichii* * recently described and illustrated by Mr. Carter, which he informs me has therein by mistake been called '*Corticium*,' I do not think I can do better than hand it over to him for technical record."

Having thus premised Dr. Millar's remarks on his discovery, I now proceed to comply with his request.

Alectona † *Millari*, Crtr. n. sp.

Amorphous, excavating, membranous, cellular, consisting of simple, fibreless sarcode (now, i. e. in its dried state, brown and gum-like), charged with the spicules of the species and projecting outwardly, in processes of different forms and different degrees of length, until some reach the surface, where they appear like flattened papillæ. "Processes" of two kinds, viz. those which form papillæ on the surface, which are comparatively large, and those which extend more or less into the substance of the coral, which are minute. Papillary processes of two forms, viz. one with an irregularly circular, more or less flattened, cribrate head, in which the spicules of the species, imbedded in sarcode, produce a cribriform structure dividing the area of the head into a variable number of minute apertures, each of which in all probability, when fresh, is provided with a delicate sphinctral diaphragm of sarcode (Pl. XVII*a*, Figs. 1 and 2); and the other, with a conical head in which the spicules are arranged radiatingly, so that when retracted in the living state, a *single* large aperture only would be presented. Each form of the papilla when largest, about $\frac{1}{24}$ inch in diameter, but variable, down to $\frac{1}{225}$ inch with holes in the latter correspondingly small, viz. $\frac{1}{1800}$ to $\frac{3}{1800}$ inch in diameter. Minute conical processes or points engaged in excavating the coral, but all charged to the extremity with spicules of the species,

* 'Ann. and Mag. Nat. Hist.,' vol. iii. 1879, p. 353.

† *Alecto*, one of the Furies.

especially the largest, which will be described presently, Fig. 1, *c c*. Pore-areæ represented by the cribriform, and vents by the conical papillæ respectively. Spicules of four forms, viz. 1, the largest or skeleton-spicule, acerate, abruptly curved or rather bent in the middle, covered with tubercles arranged linearly and longitudinally in twelve rows; tubercle simply conical, or divided into two or more portions at the extremity, arranged alternately in adjoining rows extending over the ends of the shaft, so as to render the latter obtuse and irregular; medullary canal angular in the centre and more or less undulating throughout; skeleton-spicule about $\frac{1}{72}$ by $\frac{1}{900}$ inch in its greatest dimensions (Fig. 3); 2, sub-skeleton-spicule, acerate, also abruptly curved or bent in the centre, more or less obtusely pointed at the ends, sparsely covered with tubercles irregular in number and situation, sometimes absent altogether, about $\frac{1}{200}$ by $\frac{1}{4000}$ inch in its greatest dimensions, but very variable in all respects (Figs. 4 and 5); 3, acerate undulating, almost immeasurably fine, hair-like, with an enlargement in the centre barrel-shaped, inflated in the middle and at the ends respectively, about $\frac{1}{360}$ inch long; 4, flesh-spicule, consisting of a straight microspined shaft, interrupted in its course by two circles of tubercles equidistant from the extremities and from each other, about $\frac{1}{1000}$ inch long, but very variable in size, and in number and disposition of the tubercles (Figs. 6 and 7). Spicules scattered more or less generally throughout the sarcode of the sponge, where they appear to be chiefly congregated, especially the larger ones, in the projecting processes. Size indefinite, extending in this instance throughout the main stem and branches of the specimen of *Amphihelia oculata* which is about 5½ inches long and 2 inches in transverse diameter, the thickest branch being ⅜ inch in diameter.

Hab. Marine, in the coral of *Amphihelia oculata*, Duncan.

Loc. North Atlantic Ocean, between N. of Scotland and Faroe Islands ('Porcupine,' 1869, Sta. 54); lat. N. 59° 56′; long. W. 6° 27′; depth, 363 fathoms; bottom temp. 31° 4′.

Obs. Examined in the dried state. This evidently is a variety of, if not the same species as *Gummina Wallichii* (*mendose scrip.* "*Corticium*" *l. c.*) under a slightly different form of spiculation, of which species it is stated * that "further observation" could only determine its real nature, as so little of it had been obtained, that this could not then be even satisfactorily inferred. Curious enough, this had hardly been published before Dr. J. Millar found the specimen above described in *Amphihelia oculata*, which is so like *Gummina Wallichii* that no doubt can be entertained of the latter belonging to the "excavating sponges," and that, too, to one of the most devastating kinds that I have met

* Page 354 *op. et l. c.*

with. Were we only to see a fragment of the brown substance from the interior of the coral in its *dried* state, the homogeneous, fibreless character of the then gum-like sarcode, although charged with spicules, might induce one to think that it belonged to the Gumminida, and so, provisionally, I called the species described in the 'Annals' (*l. c.*) *Gummina* (*mendose, Corticium*) *Wallichii;* but Dr. Millar's discovery undoubtedly proves it to be an "excavating sponge," so the generic name "*Gummina*" will still have to be changed to meet this in the way that will presently be mentioned.

The spiculation in *Alectona Millari* (it is the only form that I can give to "Alecto," which has been so often used, and as often transformed, for other things), is somewhat different from what I have figured of *Gummina Wallichii* (*l. c.*), and these differences are as follows:—In the skeleton-spicule (No. 1) the tubercles are conical or divided at the extremity, and not smooth, round, inflated, flattened and undivided as in *G. Wallichii;* while the earlier untubercled form of this spicule (pl. xxix. fig. 6, *op. et l. c.*) coming so near in size to the large tubercled form, I have not seen in *A. Millari;* but there are much smaller ones, viz. No. 2, that might stand for this, and amongst these every grade in form between the large skeleton-spicule No. 1 and the minute flesh-spicule No. 4. So that when compared with the spiculation of *Gummina Wallichii* as a standard, the whole of the former, characterized by their extreme variability, can only be considered as derivative from the latter, and hence my opinion that *Alectona Millari* is only a variety of *Gummina Wallichii.*

At last, then, the nature of this sponge has been discovered, whose singularly beautiful skeleton-spicules created such a desire to know their origin; and thus, as just stated, it becomes necessary to change the name "Gummina" to the generic one of "Alectona." With this, too, it seems desirable, now that three distinct genera of "excavating sponges" are known, the whole should, from this distinguishing peculiarity, be placed under one family, to which hereafter it is very possible that more may be added. To effect this I would propose the following classification, viz.:—

Order VI. Holorhaphidota.

Family. *Eccœlonida.**

Char. Sponges burrowing in hard calcareous objects, organic and inorganic, communicating with the exterior through small fenestral openings; sarcode fibreless, but spiculiferous.

Gen. 1. *Cliona*, Grant, 1826.

Possessing a pin-like spicule, with or without subskeleton and flesh-spicules. Flesh-spicule sinuous, smooth, or microspined.

* ἐκκοιλαίνω, to hollow out.

Gen. 2. *Thoosa*, Hancock, 1849.

Form of skeleton-spicule undetermined (? "multifid"). Flesh-spicule nodular, consisting of a stout shaft, terminated at each extremity by a globular inflation, and encircled by two rings of similar inflations equidistant from the extremities respectively and from each other.*

Gen. 3. *Alectona*, Crtr., 1879.

Skeleton-spicule acerate, abruptly curved or bent in the centre, tubercled throughout. Flesh-spicule spindle-like, consisting of a straight shaft, pointed at the extremities and encircled by two rings of tubercles equidistant from each other and from the ends of the shaft respectively.†

It is not improbable that *Samus anonyma* ‡ may have to come in as a fourth genus.

Lastly, I would observe, with reference to *Alectona Millari*, that on one part of the specimen of *Amphihelia* was an irregular mass about two lines in diameter horizontally, and $\frac{1}{24}$ inch high, opaque and cream-coloured, looking very much like a bit of *Alcyonium*, especially from the form of its spicules when viewed under the Microscope, but which, on the application of acid, proved to be entirely siliceous and identical in spiculation with *A. Millari*. Thus, *A. Millari*, like *Cliona celata*, may leave its burrows and grow up externally into a massive form.

The papilla, too, may be represented by a solid mass or plug of spicules, when it appears to have become effete, and the whole mass externally, composed of sarcode charged with spicules of the species mixed with, and finally faced by foreign material, i. e. quartz-sand, with a slight admixture of carbonate of lime, which causes it to effervesce under the influence of acid; thus entirely devoid of pores or passages.

Rhaphidotheca, Kent, 1870.

('Ann. and Mag. Nat. History,' vol. vi. p. 222, pl. xv.)

Rhaphidotheca affinis, n. sp.

Another sponge found and recognized by Dr. Millar upon this specimen of *Amphihelia oculata* is similar to that described and illustrated by Mr. Saville Kent,§ which came from a specimen of a like kind, viz. *Lophohelia prolifera;* that is, it consists of an

* See Hancock's figure and description, 'Ann. and Mag. Nat. History,' 1849, vol. iii. p. 346, pl. xii. figs. 2, &c.; also ibid., 1879, vol. iii. pl. xxix. fig. 21.

† Ibid. ib., p. 353, pl. xxix. figs. 5–9, *Corticium*, now *Alectona Wallichii*.

‡ Ibid. ib., *l. c.* p. 350, pl. xlix. fig. 1, &c. § *Op. et l. c.*

Esperia faced by a crust of pin-like spicules arranged perpendicularly to the surface of the *Esperia*, with their heads outwards and their pointed ends struck into the dermal layer of the latter like pins into a pin-cushion, so that these spicules appear to have been appropriated by the *Esperia* itself, as I have before stated.* But the fragment found by Dr. Millar not being more than one-third of an inch in diameter, and very imperfect, does not afford sufficient character for a description of the general form of the sponge, although the details are quite enough to prove that it is what I have stated. Herein, however, consists the most important part, for the heads of the pin-like spicules and the anchorates respectively are different in form from those of *Rhaphidotheca Marshall-Hallii* Kent.† Thus, the head of the former is flask-shaped elongate (Plate XVII*a*, Fig. 1), while that of *R. Marshall-Hallii* (Fig. 2) is globular oblate;‡ and the small end of the inequianchorate comparatively longer and truncate (Fig. 3), not round and comparatively shorter as in that of *R. Marshall-Hallii* (Fig. 4).§ In every other respect *R. affinis* is almost identical with *R. Marshall-Hallii*, as slight differences in the size of spicules, such as may be found in the larger bihamates of *R. Marshall-Hallii*, go for nothing in specific distinction; while the head of a pin-like spicule and the form of an inequianchorate often vary much, even in the same individual. Still, the differences in the form of the anchorate here seem to me to be sufficient to constitute a variety, if not another species of *Esperia*, and hence I have designated it "*affinis*"; while the difference in the heads of the pin-like spicules respectively, still further strengthens this view. The pin-like spicule and anchorate of *R. Marshall-Hallii* from a fragment of the type-specimen, are figured in the Plate by the side of those of *R. affinis* for comparison.

As, however, the form of the pin-like spicule both of *R. Marshall-Hallii* and *R. affinis*, especially as regards its head, has, with much search, not yet been found in any sponge possessing a pin-like spicule, either as a *Cliona* about the specimen of *Amphihelia*, or elsewhere, it becomes questionable whether the difference has not been produced by the *Esperia* after these spicules had been appropriated; for the sarcode has the power of producing such changes by the addition of more siliceous material in Sponges where the spicules themselves have been produced.

Still the value of Mr. Kent's record now becomes evident, for what he has stated Dr. Millar has found to be repeated in another species, and therefore it may fairly be inferred that other instances of a like nature may follow.

As regards the absence of the sinuous flesh-spicule in *R. affinis*, while it is present in *R. Marshall-Hallii*, this does not militate

* 'Ann. and Mag. Nat. Hist.,' 1878, vol. i. p. 170.
† Ibid., 1870, vol. vi. pl. xv. ‡ Ibid., *l. c.* fig. 6. § Ibid., *l. c.* fig. 7.

against the probable *appropriation* of these spicules; while the presence of the *Esperian* rosettes in *R. affinis* (where they are abundant), and their absence in *R. Marshall-Hallii*, is met by the facts—first, that when inequianchorates have attained their full development in the rosettes, the latter break up and they are dispersed; and second, the statement of Dr. Bowerbank that, wherever there are *inequi*-anchorates there may or may not be rosettes.

EXPLANATION OF PLATE XVII*a*. FIGS. 1–4.

FIG. 1.—*Rhaphidotheca affinis*, n. sp. Pin-like spicule. Scale $\frac{1}{24}$ to $\frac{1}{1800}$ inch.

FIG. 2.—*R. Marshall-Hallii*. Pin-like spicule. Same scale.

FIG. 3.—*Rhaphidotheca affinis*. Inequianchorate. *a*, front view; *b*, lateral view. Same scale.

FIG. 4.—*R. Marshall-Hallii*. Inequianchorate. *a*, front view; *b*, lateral view. Same scale.

N.B.—The pin-like spicule and inequianchorate of *Rhaphidotheca Marshall-Hallii*, drawn from a fragment of the type-specimen, are introduced here for comparison.

XXVII.—*On a New Genus of Foraminifera (Aphrosina informis), and Spiculation of an unknown Sponge.*

By H. J. Carter, F.R.S., &c.

(*Read* 11*th June*, 1879.)

Plate XVII*a*, Figs. 5–12.

On the same specimen of the coral of *Amphihelia oculata* wherein Dr. Millar found *Alectona Millari*,* I also found a species of Foraminifera which I think must be considered the type of a new genus. It had grown round a hole about three-quarters of an inch in diameter formed by the sudden reunion of a branch which had undergone division (Plate XVII*a*, Fig. 5, *d*); and resembling a bit of froth which consists of vesicles of different sizes, irregularly spread abroad and heaped upon each other, I have designated it thereafter, thus giving it the following name and description, viz.:

Aphrosina† *informis*, nov. gen. et sp.

Amorphous, flat, spreading; slightly convex and uneven superiorly or on the free surface; smooth and uniform below or on the fixed surface, where it is attached to the object on which it has grown; margin thin and irregular. Composed of a great number of vertically compressed chambers of different shapes and sizes formed successively one after another, and sometimes one upon another with the greatest irregularity, presenting on the surface a number of convexities corresponding with the shapes and sizes of the chambers below respectively (Fig. 6). Surface presenting a

EXPLANATION OF PLATE XVII*a*. Figs. 5–12.

Fig. 5.—*Aphrosina informis*, n. gen. et sp. *a*, portion of the coral of *Amphihelia oculata*; *b*, hole formed by the reunion of the branch *c*; *d*, *Aphrosina informis* in situ. Natural size.

Fig. 6.—The same. Diagram. Fragment of the surface to show its convexities opposite the subjacent chambers. *a*, puncta representing hemispherical tubercles; *b*, apertures on the margin.

Fig. 7.—The same. Diagram. Vertical section to show—*a*, cavity of chamber; *b*, intercameral aperture; *c*, arch or upper wall; *d*, floor or lower wall; *e e e*, manner in which the chambers are successively added.

Fig. 8.—The same. Diagram. Fragment to show the apertures.

Fig. 9.—The same. Diagram to scale of $\frac{1}{24}$ to $\frac{1}{1800}$ inch showing linearly—*a a a*, the polygonal division and its pore tesselating the surface; and *b b b*, the hemispherical tubercles; all relatively magnified both as to size and position.

Fig. 10.—The same. Diagram of vertical section drawn to same scale, showing—*a a a*, prismatic pillars and their tubes respectively; *b b b*, hemispherical tubercles; all relatively magnified both as to size and position.

Fig. 11.—The same. Aperture, on same scale.

Fig. 12.—Spiculation of unknown sponge. *a*, skeleton-spicule; *b*, bihamate; *c*, equianchorate. Drawn to the scale of $\frac{1}{24}$ to $\frac{1}{6000}$ inch, and all relatively magnified.

* Vide preceding paper.

† Ἀφρός, sea-froth.

minute tesselation of polygonal areæ in the centre of each of which is a punctum or pore, and irregularly scattered over this again, a great number of hemispherical tubercles (Fig. 9, *a*, *b*); polygonal areæ about $\frac{1}{1000}$ inch in diameter; pore about $\frac{1}{8000}$ inch; hemispherical tubercle, which is hollow, from $\frac{1}{900}$ inch to $\frac{1}{360}$ inch in diameter, and from $\frac{1}{900}$ inch to $\frac{1}{180}$ inch apart (Figs. 9 and 10, *a*, *b*). *Internal structure:* largest chamber about $\frac{1}{20}$ inch in horizontal diameter and $\frac{1}{30}$ inch high (inside measurement); more or less filled, with (now) dry apparently homogeneous sarcode, that is, without fragments of sponge-spicules or any other foreign material; arched over superiorly and more or less straight inferiorly, that is, following the surface of the object on which it may be growing (Fig. 7, *a*); upper wall about $\frac{1}{360}$ inch thick, constructed of vertical prismatic pillars in juxtaposition traversed by a central tube whose external end, together with that of the prismatic pillar, forms the minute tesselated surface above mentioned, and its inner end that of the roof of the chamber, through which, communication between the external and internal parts of the test is effected; pillars arranged perpendicularly to the curve of the wall and together with their tubes of the same diameters as the polygonal areæ and pores of the surface respectively (Figs. 7, *a*, and 10, *a*). Chambers communicating with each other by means of one or more apertures (Fig. 7, *b*). Lower wall or floor (Fig. 7, *d*) less thick than the roof, but still traversed more or less by the vertical tubulation, and presenting a larger hole here and there which must have allowed the sarcode of the chamber to come into direct contact with the coral. Aperture in plurality on the margin opposite the chambers respectively supported on a papillary projection about $\frac{1}{360}$ inch in diameter; the hole itself about $\frac{1}{900}$ inch (Figs. 8 and 11). Size of specimen about one inch in diameter, that is, three times that of the circular space in the coral which it surrounds; maximum thickness about $\frac{1}{30}$ inch.

Hab. Marine, on the coral of *Amphihelia oculata*.

Loc. North Atlantic Ocean, between N. of Scotland and Faroe Islands ('Porcupine,' 1869, Sta. 54); lat. N. 59° 56′; long. W. 6° 27′; depth, 363 fathoms; bottom temp. 31° 4′.

Obs. Of this species I have already stated that it appears to be new, and although it is to a certain extent like Carpenteria, it nevertheless differs in the flat, vesicular character of its chambers extended more or less horizontally over the same plane; in the absence of elongated branched apertures; and that of foreign material (fragments of sponge-spicules, &c.) in its sarcode, with which the chambers of Carpenteria are invariably filled. The presence of hemispherical tubercles scattered over the poriferous surface is a common occurrence or feature on the tests of many Foraminifera; while the prismatic structure of the wall in which

each prism is traversed by a tube, represents the so-called "pore tubulation."

The vesication of *Aphrosina informis* forcibly recalls to mind that of *Æthalium septicum*, whose active state is so like *Amœba*; and whose form and appearance sometimes, are almost identical with *Lieberkühnia Wagneri*.*

Spiculation of an unknown Sponge.

On the surface of the foregoing species of *Aphrosina informis* are plentifully strewn the spicular remains of an unknown sponge remarkable for the size of the larger bihamates, which almost equal in length the skeleton-spicule, and on this account it seems desirable to record the fact, together with an illustration of each spicule drawn to the same scale, viz. $\frac{1}{24}$ inch to $\frac{1}{6000}$ inch, in order that their relative sizes may be at once realized.

Skeleton-spicule acuate, slightly fusiform, and sometimes spinulate (Plate XVII*a*, Fig. 12, *a*); large flesh-spicule bihamate, simple, smooth, showing plainly the central canal (Fig. 12, *b*); small flesh-spicule equianchorate, navicular, alæ or flukes inflected (Fig. 12, *c*).

Skeleton-spicules in successive bundles, indicating a fibrous arrangement, among which the bihamates of various sizes are plentifully scattered, together with a few equianchorates. The spiculation somewhat resembles that of *Esperia villosa*.†

* Clap. et Lach., 'Études Infusor.,' vol. i. pl. 23.

† 'Annals,' 1874, vol. xiv. pl. xiii. fig. 13, &c. ('Porcupine' dredgings).

XXVIII.—*On the Theory of Illuminating Apparatus employed with the Microscope.* Part I.

By Dr. H. E. Fripp, Ex.-Off. F.R.M.S.*

(*Read 11th June*, 1879.)

Whoever tries to explain the diverse practice of microscopists in illuminating difficult objects, will find it equally hard to reconcile the conflicting opinions upon which this practice is based, and the contradictory results obtained by the methods employed. And the question will naturally arise in his mind, whether all microscopists accept in the same sense, and with the same confidence, those optical principles whose validity is beyond question, but whose practical import depends entirely upon their correct application.

For when the performance of the different kinds of illuminators is under discussion, the sincerity of appeal to optical principle often seems so dubious that one cannot but be impressed with the conviction of the expediency of reconsidering the whole theory of the action of the various apparatus now in use.

If there be no common ground of accepted doctrine it is obviously impossible to institute precise comparisons of the several excellencies, defects, or relative fitness for the particular purpose for which each illuminator is used (or designed), until some general rationale of their optical action has been established, and the more or less perfect realization of this optical rationale has been demonstrated for each case. My aim, therefore, in the present paper is to systematize as far as lies in my power those general propositions which, if accepted as rightly representing the optical aspects of the subject, may be used as a basis and standard of such comparisons. But while it is necessary to keep in view the various modes of action of the various apparatus used, in order to draw the particular conclusions upon which general propositions may be founded, I purpose to avoid all side issues involved in the attempt to decide for or against the claims severally advanced by the advocates of one or the other illuminator. It would indeed be impossible to include within prescribed limits a reasoned estimate of the performance of each separate invention, and equally fruitless to enter upon bypaths of theory which only interest those who are studying special objects and employing unusual methods of procedure according to the requirements of the illuminator used or object examined. Any inferences here drawn on general theoretical grounds respecting the real worth and use of the several classes of illuminators, will turn not upon art and skill of construction, but upon the optical intention and actual fulfilment of service in perfecting the definition of the Microscope image. In a word, my

* President of the Bristol Naturalists' Society.

standpoint is *the direct co-ordination of the illuminator and objective considered as parts of the same instrument tending by one combined series of acts to a common result in which the function of each part is a complement of the other.*

But it may be objected that a *theory* of illumination is better replaced by the *practice* which has long been successfully carried out by force of instinct aided by a little empirical manipulation, and that every microscopist can thus gain sufficient insight and mastery of his instrument to become independent alike of the restraints of theory and the methods of science. Or that, if inclined to rest his practice on a firmer foundation, he has only to turn to some "manual" and find therein all needful guidance. Such, indeed, is the general belief; and he who dissents from it in the face of current opinion and "authority" will scarcely escape the imputation of prejudice or presumption. Nevertheless I put in my plea of "not guilty," and proceed to offer reasons for dissent from the popular creed.

1. The microscopic image cannot be interpreted by mere intuition or insight of indisputable self-evident realities, but is the outcome of a prolonged study of optical phenomena occurring under unusual conditions, and presented to the eye in an unusual form. Visual perception may be correct as regards the optical effects presented, but this does not ensure accuracy of inference regarding the objective facts which are their antecedent. Experience teaches us that a perfect optical image requires a critically perfect illumination of the object; but a knowledge of optical effects as complete as exact science can make it is required before this illumination can be effected with certainty and constancy. No amount of practice will confer the power of discriminating between adventitious effects (which are yet true in an optical sense) and those which really characterize some structural detail of the object. The fact that a clearly seen and perfectly defined image is in a large number of cases *not* conformable with the object itself has been demonstrated beyond possibility of dispute.*

2. Yet our handbooks have nothing to say on these matters which can assist even the novice in his theoretical studies. The ordinary schoolboy crib from some elementary treatise on dioptrics transferred with no little parade to the introductory chapters of our handbooks as optical principles of the Microscope (!) is simply an evasion of the obligation (confessed, indeed, in the attempt) to explain the formation and character of the Microscope image. And, so far as the theory of illumination is concerned, catoptric problems of fundamental significance, such as the action of plane

* For further observations on this subject I beg to refer to various articles in the Bristol Naturalists' Society's 'Proceedings,' and particularly to an essay on the question, "Is there a Science of Microscopy?"

and concave mirror, are either omitted altogether or treated in a manner which is at variance with the first principles of optical science. The same erroneous teaching is even chargeable against some of the diagrams illustrating refraction and reflection of light, while the general poverty of diagrams explanatory of optical problems is scarcely redeemed by figures of lamps and instruments interesting only to the maker and mechanical draughtsman. So again, when practical directions are substituted for theory, inconsistencies which crop up while consulting "authorities" demonstrate the present uncertainty of rule and inconstancy of result. On the part of the general body of microscopists, this leaning towards authority weakens the power of and trust in personal observation, and proportionally lengthens the reign of divided doctrine and opinion. Thus it happens that the first difficulty encountered by the beginner—namely, the fitting illumination of objects viewed through the Microscope—still remains the last difficulty to be overcome by the experienced microscopist.

3. Since then we look in vain for any systematic exposition of the principles of action upon which the performance of the several classes of illuminator (reflecting, refracting, or combined apparatus) depends, it seems expedient to collect such evidence as our micrography may afford of the current doctrine and practice in England, in order that we may form a just estimate of the subject before attempting any alternative theoretical views. The extracts here quoted are chosen solely on account of the optical principles, implied though not always expressed, on which the practical remarks are based. In the present paper the consideration of the theory and practice of illuminating opaque objects is omitted, as this part of the subject is more conveniently treated separately, though not involving any essential difference of principle.

Mr. Ross pertinently remarks, "The manner in which an object is lighted is second in importance only to the excellence of the glass through which it is seen." And again, "The principal question in regard to illumination is the magnitude of the illuminating pencil, particularly in reference to transparent objects. Generally speaking, the illuminating pencil should be as large as can be received by the lens, and no larger. Any light beyond this produces indistinctness and glare. The superfluous light from the mirror can be cut off by a screen having various sized apertures placed below the stage" (diaphragm).

Mr. J. Smith says, "In viewing transparent objects the plane mirror is most suitable for bright daylight; the concave for a lamp or candle, which should have the bull's-eye lens, when that is used, so close to it that the rays may fall nearly parallel on the mirror. If the bull's-eye lens is not used the light-source should not be more than five or six inches from the mirror. This latter is seldom

required to be more than three inches from the object, the details of which are best shown when the rays from the mirror fall upon it before crossing, and the centre (of mirror) should be, especially by lamplight, in the axis of the Microscope. For obscure objects seen by transmitted light and *for outline* a full central illumination is commonly best; but for seeing delicate lines (e. g. on insect scales) it should be made to fall obliquely and in a direction at right angles to the lines to be viewed. The diaphragm is often of great use in modifying the light and stopping such rays as would confuse the image (especially with low or moderate powers), but many cases occur when the effects desired are best produced by admitting the whole from the mirror. If an achromatic condenser is employed instead of the diaphragm its axis should correspond with that of the body, and its glasses when adjusted to their right place should show the image of the source of artificial light, or by day, that of a cloud or window-bar in the field of the Microscope while the object to be viewed is in focus."

The above directions are quite compatible with a correct theory of illumination, though it cannot be said that they constitute any systematic expression of such a theory. If we now turn to the practical directions given by Sir D. Brewster in his article on the Microscope in the seventh edition of the 'Encyclopædia Britannica,'* we find certain directions relating to the position of the observer, the condition of the conjunctiva of the eye, the proper direction of lined objects in relation to the flow of moisture over the conjunctiva, which may be passed over, and certain rules to be observed in managing the illumination, which I here quote.

Firstly. The eye should be protected from all extraneous light, and should not receive any of the light which proceeds from the illuminating centre except that portion of it which is transmitted through or reflected from the object.

Fifthly. The field of view should be contracted so as to exclude every part of the object excepting that which is under immediate examination.

Sixthly. The light employed for illuminating the object should have as small a diameter as possible. In the daytime it should be a single hole in the window-shutter of a darkened room, and at night it should be an aperture placed before an argand lamp.

Seventhly. In all cases, and particularly when very high powers are requisite, the natural diameter of the light employed should be diminished and its intensity increased by optical contrivances.

The *eighth* direction refers to the use of homogeneous light.

Sir D. Brewster's essay on the Microscope marks an important

* Vol. xv. 1842.

date in the history of English invention of Microscope apparatus, for since this date the claim of construction upon scientific principles has been steadily preferred. It is therefore worth while to look upon the theory and practice of the present day from the standpoint of those who are its earlier founders, and whose mastery of optical science is acknowledged.

Sir D. Brewster states the case as it stood in 1820 with candid accuracy, as follows:—

"But the nature of the light employed, the magnitude of the pencil (thrown on the illuminator), its condition with regard to parallelism, divergency, or convergency, and the diameter of the pencil employed (i.e. thrown on the object), or the direction in which it falls upon the object, and upon which the performance of the finest instrument essentially depends, have never been discussed as matters of science."

The deduction by which Sir D. Brewster arrives at his theory of illumination is based upon the following physical and physiological grounds. If, he says, the object upon which a Microscope is focussed be lit by a surface containing an infinite number of radiant points, the images formed on the retina of the shadows caused by the intervention of opaque parts of the object will not be coincident, because these opaque parts cannot possibly be situate exactly in the focal point of the crossed rays, and also because of the spherical aberration which gives different conjugate foci for images formed by pencils passing through the lens at different distances from its central axis. Hence the indistinctness of the total effect produced by a number of not accurately coincident (that is overlapping) images, and the importance of illuminating the object from *one* point only. And this theory is embodied in the practical directions above quoted.

From what follows it will be seen that this physical and physiological reasoning is untenable. It is sufficient to point out here that the "condenser" which Sir D. Brewster designed with the special object of lighting the object from a point, upsets his own theory; as the source of light is practically the surface of the lens nearest to the object—a relatively large surface from which pencils of considerable angular value are directed at various inclination to the axis! consequently the illumination by daylight from a single hole in a window-shutter has no support from the practice of artificial illumination, while it is self-evident that when a mirror only is employed the illumination is simply enfeebled by exclusion of light.

It is therefore not a little remarkable that in discussing the proper method of illuminating objects for the solar Microscope (by "reflected" light), Sir D. Brewster discards the illumination from a single point, because "in consequence of the light arriving from

one direction only the surface of the illuminated object is covered with deep shadows, and the intensity of illumination is by no means sufficient when the power of the instrument is considered." Hence he proposes "that the sun's light should be reflected by a very large mirror through four apertures, each of which is furnished with an illuminating lens. By these means the light would fall upon the object in four different directions, and by shutting up one or more of the four lenses (or parts of them) we shall be enabled to find the particular direction of the light which is best suited for developing the structure."

In 1829 Dr. Wollaston's observations were made public, and a drawing of his condenser given in the 'Philosophical Transactions'; and we next quote from Sir D. Brewster's essay * the following passage:—"The marked difference between the methods of illumination proposed by Dr. Wollaston and Sir D. Brewster, induced the latter to publish in 1831 a paper "On the Principle of Illumination of Microscopic Objects." In this paper the mistake committed by Dr. Wollaston is clearly pointed out. The rays which Dr. Wollaston throws upon the object, in place of being *rays actually converged to a focus*, as they ought to be, are rays which diverge from a focus situated between the object and the lens. He makes the focal point of the circular margin of the perforation (that is, the diaphragm) fall upon the object without considering that the rays which pass through that perforation do not diverge from it, and therefore cannot be collected in the conjugate focus corresponding to the perforation. In Dr. Wollaston's diagram † the rays which are incident on the mirror are actually drawn as parallel rays, and it is quite clear that he meant them to be parallel rays issuing from the bull's-eye lantern which he recommends. But if we suppose that a common flame is used, the error is just of the same nature. It is a distinct image of the flame that should be thrown on the object, and hence the perforation (diaphragm aperture) should be placed close to the flame, the source of light and the illuminated object forming the conjugate foci of the lens."

It is not for the sake of controversy, but because the sharp criticism of Dr. Wollaston's invention by Sir D. Brewster offers a starting-point for a more progressive discussion of the theory of illumination, that the present writer ventures in a humble way to re-enact the part of *sartor resartus*.

It is first of all to be noted that the original intention of an illuminator which should *collect* light on the object was not to *condense* it, but to exclude any other rays from the field of vision except such as came through or from the object. Dr. Wollaston lays down the following proposition which Sir D. Brewster accepts

* 'Encyclop. Brit.,' vol. xv. p. 49, 7th ed.
† 'Phil. Trans.,' 1829, plate ii. fig. 1.

as the same, "though not so fully developed," as his own propositions enunciated in 1 and 5. "In the illumination of microscopic objects, whatever light is *collected* and brought to the eye beyond that which is fully commanded by the object-glasses tends rather to impede than to assist vision." In the next place, Dr. Wollaston plainly states that the intensity of illumination will depend upon the diameter of the illuminating lens and the proportion of the image of the aperture to its actual size, "which may be regulated according to the wish of the observer." Here we see the "marked difference between the principles respectively advocated by Dr. Wollaston and Sir D. Brewster. The former advocates the principle of illumination from a large radiant surface, employing at the same time a method of regulating the amount of light derived from the original source by a diaphragm perforation. The latter arranges a circumscribed and small area of light-source, a point of light which is transferred to the object as a point of light of exactly the same size, the two points being conjugate foci. Now it is obvious that in both illuminators the intensity of light is not gained by *condensation*, but by *nearer approach to the object*; the brightness being inversely proportional to the square of the distance from the light-source. It is equally certain that in both illuminators the surface of the lens nearest the object is practically the light-giving source.* In the illuminator of Sir D. Brewster the light spreads first upon the collecting surface of a lens much larger than the diaphragm aperture, and after various changes of direction is again concentrated on the object. Yet in reforming the original point of light the rays previously dispersed until they occupy the whole surface of the lens which focusses them on the object, fall in from this radiant area with converging lines of various inclination to the axis: thus fulfilling the very conditions which Sir D. Brewster considered unsuitable, and which he sought to remove by an apparatus which, after all, acts upon the "mistaken principle" charged upon Dr. Wollaston! Fortunately, however, for microscopy, the modern objective not only enables, but demands, the adoption of this principle, which perhaps in 1829 Sir D. Brewster had some grounds for denouncing as a mistake when single lenses with great spherical aberration were the only objectives in use.

It remains now to examine Sir D. Brewster's criticism, as quoted above, on Dr. Wollaston's optical diagram and its explanation. The rays incident on the mirror are drawn parallel (the same blunder is repeated to-day in our handbooks!), and Sir D. Brewster says truly that the image of the diaphragm aperture could not fall

* Anyone may satisfy himself of this fact by looking at a light (of any kind) through a lens placed before the eye at the principal focal distance; when the whole surface of the lens will be seen equally radiant, while the primary *source* is not seen.

upon the object unless the rays diverged from the diaphragm towards the "condensing" lens. But by constructing the diagram (as here given) *from the object as the starting-point*, we readily see that a light-source placed in the position indicated ($c f$) would

Fig. 1.

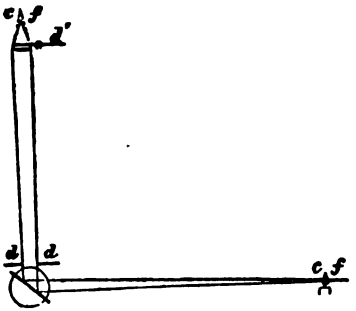


Fig. 2.

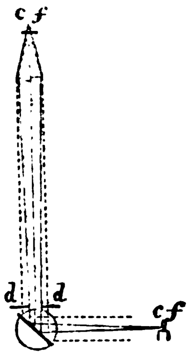


Fig. 1, from Dr. Wollaston's data.

Length of tube	6	inches.
Focal distance of object from lens	·8	"
Distance of lens from diaphragm	4·4	"
Aperture in diaphragm	·3	"
Radius of lens to give the focal distance wanted	·4	"
Diameter of front surface of ditto	·4	"

$c f$, Conjugate foci by construction showing diverging pencil from light-source.

Fig. 2, copied from p. 49, 'Encycl. Brit.,' Sir David Brewster's article on Microscopes.

Focal distance of object from lens	1·14	inch.
Distance of lens from diaphragm	4·7	"
Aperture in diaphragm	·2	"
Radius of lens	·5	"
Diameter of front surface	·6	"

Both figures show the effect of the diaphragm aperture in determining conjugate foci and divergence of pencil. Fig. 2 is, however, not drawn to scale accurately in accordance with Dr. Wollaston's data, and therefore exaggerates the supposed error of focus.

Dotted lines show the focus for parallel rays. Continuous lines, conjugate foci.

N.B. By this arrangement the upper surface of the condensing lens becomes virtually the light-source, and the diaphragm aperture just over the mirror acts on the same principle as in the Brewster illuminator. Obviously the best arrangement would be to leave the mirror free and remove the diaphragm, placing a revolving diaphragm with apertures just over the lens at d'.

give the necessary outlines of the diverging and converging cones, the apices of which shall be conjugate foci. But Sir D. Brewster's illuminator effects nothing more, and in passing judgment on the position of the diaphragm in Dr. Wollaston's apparatus, he lays himself open to objections of a graver kind against his own arrangement.

For since, theoretically, any plane below the diaphragm (or even its own aperture) may be considered the illuminating surface whether the light reaches such a position directly or by means of reflecting or refracting media, the best position of diaphragm may consequently be affirmed to be *above* the last reflecting or refracting surface, as thus the regulation of light-intensity may always be controlled without any change of apparatus. But it is a matter of daily experience that the position of the diaphragm in Microscopes of various model, and in "condensers" of various construction, is *not* dependent upon the principle contended for by Sir D. Brewster, namely, of immediate proximity to the light-source, since in all later constructions the diaphragm is a constituent part of the condensing apparatus, and situate always at some distance from mirror or lamp. The reason for which may be found in the principles here enunciated.

What is, however, practically valuable in the illuminators of Wollaston and Brewster, is not the application of a single narrow axial pencil of light, but of a comparatively wide illuminating cone whose base is formed by the radiant surface of the collecting lens next the object. And the suggestion therein conveyed covers most of the designs subsequently adopted of combining with an illuminating lens diaphragms pierced with apertures of various size and form giving oblique, central, or full all round illumination. But microscopy is more particularly indebted to Sir D. Brewster for his emphatic advocacy of a scientific study of a too long neglected subject. "The art of illuminating microscopic objects is," he says, "of no less importance than that of preparing them for observation," and he reiterates in the same article his conviction that "the progress of discovery with the Microscope must depend upon the scientific illumination of the objects under examination." And again, "I have no hesitation in saying that the apparatus for illumination requires to be as perfect as the apparatus of vision; and on this account I would recommend that the illuminating lens should be perfectly free from chromatic and spherical aberration, and that the greatest care be taken to exclude all extraneous light, both from the object and from the eye of the observer." *

Dujardin and others taught the same doctrine that Wollaston contended for, namely, that a converging light was best. Pritchard, on the contrary, held that difficult test objects could be best seen with diverging light. Harting, who mentions Pritchard's

* The Jury in a Report on Microscopes exhibited at the first world's fair (1851), mention Sir D. Brewster's method of illumination by achromatic lens combinations placed beneath the stage, and state their belief that it is a great advance on the simple condenser of Dr. Wollaston. But, as above shown by diagrammatic construction, Dr. Wollaston's condenser effects the very same result —a conjugate image and an illuminating pencil of considerable angular convergence.

view of the matter, tries to explain it as an effect produced by the *object* upon the course of the rays passing into the objective, and proposes an eclectic mode of solving the difficulty, by employing parallel, converging or diverging rays, according to the nature of the object, and other circumstances special to each case. He further says, speaking of the means by which, as he supposed, a proper direction could be given to the illuminating rays, that the *shape* of the plane mirror was a matter of indifference, while of course the concave mirror must necessarily be round. Goring, on the contrary, maintained that the mirror should be shaped elliptically, and as large as possible (5 × 4). Schleiden remarks that where it is possible, light from a plane mirror is to be preferred, because parallel rays are more advantageous for correct observation, although they give a less intense light. "For it appears," he adds, "as though a shifting of the image was occasioned by the convergence of rays reflected from the concave mirror." But though he has often observed this, he confesses that he cannot explain it, and that "our opticians leave us in respect to this matter quite in the dark." *

Dr. Carpenter, in his article on the Microscope,† follows Sir D. Brewster in his explanations and directions respecting illumination. I quote the following extracts:—"The principle of illumination on which Sir D. Brewster lays great, and we think fully deserved stress, is that the focus of the illuminating rays shall be coincident with the object so that there shall not be two sets of rays at different angles, one proceeding from the luminous object (source of light?) and the other from the object to be magnified." Commenting further on the best means of developing this principle, Dr. Carpenter says, "The rays of light proceeding from the radiant point being brought to a focus by the 'condenser' on the object, cross each other there, and should proceed to the object-glass of the microscope as if they came from the object itself. Now unless they are made to converge upon the object at the same angle at which they diverge to enter the objective, we cannot but think that a source of error still remains, and that the most perfect image possible formed by an achromatic object-glass of an object which is artificially illuminated, can only be produced when the rays from the source of light take exactly the same course as if they proceeded from the object itself. That they may have this course they must be made to converge upon the object by a condensing lens whose focus for parallel rays shall be the same as the acting focus of the objective. A different condenser would thus be required for every objective."

But the practical experience of this able microscopist does not

* Quoted from Nägeli and Schwendener, 2nd ed. p. 92.
† Todd's 'Cyclop. Anat.,' vol. iii. 1847.

appear to have agreed with the theory propounded by the authorities of the day, as will be seen from the following extract:— "We may mention it as a fact for which we cannot very well account, that we have been able to obtain a very beautiful and distinct illumination by the use of an aplanatic doublet condenser, receiving its rays from the ground-glass globe of the common table-lamp, which would not seem to furnish any of the conditions that we have dwelt on as of theoretical importance."

In respect to the opinions expressed in the above quotations, I need at present only remark that although a theory of illumination is partially indicated in the acceptance of Brewster's "achromatic condenser" and the principle of its mode of action, as explained by its inventor (which has already been criticized), the suggestion of optical relation between the size of the illuminating cone and the aperture of the objective, more distinctly asserted by Ross (see *ante*), is based upon the assumption that every objective works best at its fullest aperture, which is rarely the case, and that "definition" and "penetration" are always improved by intense light, which is the case only when the focussing function of the objective is absolutely perfect; and even then definition becomes more critical as the *whole* aperture of the objective is occupied at the same moment. Sir D. Brewster's insistance on the propriety of using a narrow point of light, amounts in practice, when his illuminator is used, to this—that its specific intensity is first equalized by being distributed over a large radiant surface, viz. of the lens next to the object, and then directed from a number of radiant points in lines converging on the object. The true rationale of "definition," so far as brightness of illumination is concerned, is indicated by Helmholtz in his essay "On the Limits of Optical Capacity of the Microscope," written at a much later date. Sufficient delineating shadow, he says, can only be got by narrowing the size of the illuminating pencil, and a comparatively large illuminating cone can be applied beneath the object only when the objective admits a large incident cone. But it must be borne in mind that large angular aperture is associated with high magnifying powers, and as the optical aperture of such objectives diminishes with each increase of magnifying power, diffraction effects begin to affect the delineation. The theory of these diffraction effects was not however studied or followed out to its proper conclusion by any writer of that date. Again, it has been fully demonstrated that the function of large aperture is summed up in the admission and transmission of diffraction pencils, caused by the splitting of such pencils of light as fall upon minute details of the object into diffraction pencils which do not follow the original direction of the pencils thrown by the illuminator. And although fresh detail is thereby introduced into the image by an objective of

large aperture, *when the object contains such detail*, the greater admission of light through such an objective when viewing an object which does *not* contain such detail, severely tests its capacity of definition by flooding out the delineating shadows. Thus the benefit of a wide illuminating cone is confined to particular cases, and is not of general application.

Further, as respects the necessity of a different condenser for every object: everyone is of course aware in our day that a single illuminating lens, if constructed to admit the widest pencils required for any objective, can also be used for objectives of lesser aperture, when the incident light is regulated by a diaphragm properly placed at the plane of its lower focus, and supplied with openings of the required size. But this regulation of the size of incident pencils did not enter into the design of the Brewster illuminator, and it may fairly be inferred that the special function of a diaphragm as now used was not then (as it is not always now) comprehended. The Brewster design has indeed been long superseded by arrangements which leave the mirror free and yet combine refraction and reflection of light in pencils of any desired angular magnitude applicable to central or lateral illumination as well as for showing a positive image on a dark background, so that every desired mode of illumination may be effected without change of apparatus, or of the position of light-source. But for the present improved arrangements we are indebted to the practical optician rather than to any general advance in theoretical knowledge. For we still hear a great deal about "condensing" lenses, which nevertheless only increase the brightness by bringing an image of the original light-source nearer to the eye by optical means, without any actual increase of specific intensity. We are still taught the superiority of achromatic illumination, though it is easy to control by proper use of a diaphragm any excess of colour that may arise from dispersion of rays given off by reflection from mirrors, prisms, &c. And yet we still find the diaphragm, whose special function is to regulate by limiting apertures the size of the illuminating cone, placed in any chance position required by the mere mechanical exigencies of a thick Microscope stage; the usual consequence of which is that when an objective of even moderate power is used, its angular aperture is far in excess of any illuminating cone which can be brought to bear on the object, so that the full resolving power of the objective cannot be obtained without additional apparatus. And while it is universally accepted that light is shut off by means of the diaphragm, we still find the old diagrams of mirror reflection invariably indicating—in defiance of the fundamental law of incidence and reflection—a *parallel* beam of light traced in towards the object, whereas a moment's consideration must convince everyone that if light is incident with *parallel* rays upon a

microscopic object only an infinitesimally small amount of light can be directed in the axial line upon the object, and that diaphragm openings having a larger diameter than the object could have no effect of excluding light, though we know the contrary to be the case.

And this consideration brings me to remark on the singular absence of any scientific exposition of the respective functions of the plane and concave mirror, and the function of the diaphragm when employed with the mirror; although these illuminators are of fundamental import to the general theory of illumination, while their constant employment renders the science of their effectual application a matter of prime and lasting necessity.* In comparison with this extraordinary omission, the perpetually exercised ingenuity in construction of new "condensers" and reflectors of all kinds, and the much-favoured discussion of exceptional and often useless methods of illumination, fail in real and general interest. Another remarkable omission is the absence of any study of the effect of the object which intervenes at the crossing point of converging illumination and the diverging pencils of light emitted from the object. The fact is too obvious to escape the notice of any practised observer that *mere* incidence of light is not the sole determining condition of perfect definition. A complete theory of illumination requires some special study of the physical effect of the constituent particles of the object on the rays incident upon them, whether from below or above. The intervention of the object *must* break the continuity of these rays (how otherwise would delineating shadows exist?). Opaque parts interrupt more or less the passage of a large number of rays, while diffraction causes the additional phenomena of points of light which initiate a new series of light pencils whose appearance in the objective image is necessary to its perfect delineation of detail. And even where light passes through transparent parts of the object it is possible, nay probable, that its transmission is not unaffected by differences of homogeneity and specific gravity of the substance of the object (which has some thickness, even in the finest preparations). Such facts radically dispose of the received notion that transmitted light passes without change of direction through the object. The different specific density, for instance, of the fluids in which a preparation is preserved cannot but possess some influence, just as different specific density and thickness of a glass cover produce an effect for which correction of the objective has long been acknowledged to be necessary. In short, the principle of homogeneous immersion applies equally to the operation of the particular preservative menstrua used, which comprise such various fluids as glycerine, spirit, turpentine, saline solutions, &c. It is not,

* The latest editions of our Microscope manuals are as bare of information in this respect as the earliest.

therefore, too much to affirm that a right understanding of optical effects (initiated *before* the specific function of the objective is called into play) would have sufficed to expose the weakness of the strangely inadequate theory of the Microscope indicated in our handbooks by the hypotheses of penetrating and resolving powers; and that the maxim not long since considered unassailable, "No resolution without magnifying power," requires qualification in many important particulars.

The foregoing observations confirm to a large extent a statement made by Mr. Crisp in a communication read last year before the Society,* which I take the liberty of quoting here:—"At the present time," says this gentleman, "there is nothing extant which constitutes a commencement of a systematic theoretical treatment of the subject of illumination; yet, being purely optical, it is obviously capable of being so treated, and great practical advantages would undoubtedly follow from the development of an exact theory on the subject. In nothing has the ingenuity of microscopists been more exercised than in the invention of novel modes of illumination for lined objects; but however clearly these appliances may bring out particular appearances, there is good reason to believe that in the majority of cases they are illusions, originating in the character of the illumination employed, and that all possible methods of illumination may be reduced from the fifty or more kinds now existing to less than half a dozen at the most."

In adding to Mr. Crisp's milder denunciation a charge of erroneous teaching in respect of "the scientific illumination of objects" so strenuously contended for by Sir D. Brewster, I am fully sensible that such a charge requires to be sustained, not merely by the evidence above adduced of contradictory opinion and practice, as well as absence of definite rule, which prevails at the present time, but also by some alternative exposition of facts based on demonstration as well as theory. Such an exposition may be found in the respective essays of Professors Nägeli and Schwendener, Abbe, Helmholtz, and others, but as it seems to be little known or appreciated in English microscopy, an attempt to give some account of what is authoritatively taught abroad as a scientific theory of illumination, may serve at least to remove the reproach of inattention on the part of English microscopists to the *systematic* study of so important a subject. And it may be well also that the student should realize more distinctly how much of the actual performance of his Microscope depends upon the scientific application of his illuminating apparatus, even if he work with such simple illuminators as the plane and concave mirror.

It need scarcely be remarked that if the Microscope could always be turned towards a bright expanse of sky or reflected

* This Journal, i. (1878), p. 126.

sunlight (as from a cloud, whitened wall, &c.), or towards an artificial light-source of sufficient extent of surface and from every point of which an equally diffused light emanated (e. g. lamplight with ground-glass plate in front of it or reflector behind it), no other illuminator would be required for the greater number of observations made. But on account of the mechanical arrangements of the Microscope and for the convenience of the observer a mirror is an indispensable addition, while for greater control over the intensity of the light two accessory instruments are desirable: namely, a diaphragm for exclusion and a lens for collection (not condensation) of light.

In discussing the action of the plane mirror as applied to the Microscope, it must be borne in mind that from every light-source having a greater area of surface than that of the mirror itself there emanates a *converging* beam of light, which, after reflection, must converge further to a given point in the axial line of the reflected cone. If we hold a small mirror in the hand, with its surface turned towards an unlimited expanse of bright sky, and so inclined to the eye looking down upon it that the observer may see the reflected sky, then, as the mirror is held further from or nearer to the eye, a greater or smaller extent of sky is seen: or, if we look at a landscape, or a row of houses, or trees, &c., reflected from the mirror, a greater or less number of objects is included in the field of vision according to the distance of the mirror from the eye. And in every case the field of vision is circumscribed by lines drawn from the pupil to the periphery of the mirror and continued into space in the direction of incidence. A trivial experiment! but serving to demonstrate that daylight illumination with the plane mirror *must always be effected with converging light.* Each point in the surface of the mirror reflects independently in every direction the light it receives, and consequently when (in place of the eye looking upon the mirror) we suppose an object to be placed on the Microscope stage and in the optical axis of the instrument, the whole mirror appears as a self-luminous surface in relation to that object. Moreover, the luminousness of the surface remains equal, whether the surface be curved or not (supposing of course the light-source to be of practically unlimited extent). By reference to Fig. 3 it will be seen that a converging incident beam on the plane mirror is reflected on the same focal point as the parallel beam thrown on the concave mirror; and that a certain inclination of the mirror (supposing it to be centered on the optical axis of the instrument and arranged for direct central illumination) of 45° is necessary in order to reflect this converging beam on the object.

When a parallel beam of light is reflected from the plane mirror set at 45° to the axis of the instrument, the central rays alone fall on the object and the illumination is proportionally

feeble. But if the mirror be inclined forwards, backwards, or sidewards, at a greater angle, the outside rays of the beam fall with a certain obliquity, depending upon the size of the reflected

Fig. 3.*

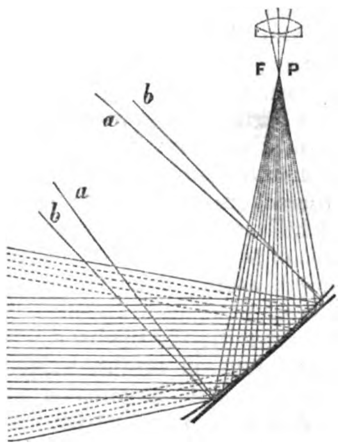


Fig. 3, to show that plane and concave mirrors have an exactly similar converging effect from the mirror upon the object.

The effect of the curve of the concave mirror is, here, to cause parallel rays incident upon it to be converged with an inclination to F P equal to that which is produced by means of the plane mirror when a larger converging cone of rays falls upon it; the area of mirror surface being practically equal in both.

Angle of aperture, 20°.
Distance of mirror from F P, 4 inches.
Radius of curve of concave mirror, 12 inches.
a a, Radii for constructing angles of incidence and reflection on concave mirror.
b b, Verticals to plane mirror.

Dotted lines = direction of incident light upon plane mirror.
Continuous lines = direction of rays incident upon concave mirror.

beam and its freedom from obstruction by the projection of stage or other impediment to free play of the light. In the small model instruments in which a relatively large mirror is centrally fixed at a short distance beneath the stage, the oblique illumination thus obtained has a marked influence upon the delineation of many objects.

When, again, the surface of light-source is reduced less than that of the mirror, the illuminating pencil falls with diverging rays upon the mirror and with corresponding diminution of light intensity, the same divergence and diminution of light effect continuing after reflection.

What now is the function of the diaphragm as ordinarily used with the plane mirror? It is evident from inspection of Figs. 4, 5, 6,†

* The dotted lines, by error of the engraver, are drawn parallel with each other: each line traced backwards from the object has its special angle of divergence from, or convergence towards, the mirror.

† Taken from the Handbook of Nägeli and Schwendener.

where A B represents the plane mirror, C D the concave mirror, *a—b*, the aperture in a diaphragm below the stage, and *p* a point in the focal plane of the object on which the Microscope is focussed, that the lines *p m*, *p n*, form the limiting boundary of a converging cone of light-rays reflected by either mirror. Assuming that the mirror is large enough to occupy the base of this illuminating cone, the intensity of illumination will vary with the size of the aperture in the diaphragm. And it matters not whether the mirror be nearer to or further from the point *p*, if only it be large enough to subtend the base of the cone: for since the area of reflecting surface increases with its distance from the point *p*, the number of illuminating points compensates for diminished intensity of light. If the diaphragm were removed, the face of the mirror would form the base of the illuminating cone, and in proportion as the mirror is brought nearer to the point *p*, will the angular spread of this cone increase.

It follows also, from the demonstration given with Fig. 3, that the cone of light from the concave mirror, circumscribed by the same diaphragm aperture, illuminates the point *p* as well (but no better) whether its focus falls exactly upon *p*, or not. As the curve is without influence in this direction, so the position of its focus has no optical significance. When the condition of unlimited expanse of sky light is realized, the converging cone of the plane mirror reflection has as good a claim to be considered "condensed" light as that of the concave mirror, or that of the collecting lens. But when its surface does not afford a sufficiently large base for a cone of light, which might act with real optical effect through a given diaphragm aperture, it is then deficient: and when it is sufficient for all effects the diaphragm has a special function to fulfil in controlling by exclusion or admission the amount of light required for each object according to the magnifying power of the objective used.

But in the next place, if we compare the outward course of the lines (in Figs. 4, 5, 6), which represent the incidence of the respective cones of light falling upon the two mirrors from the respective light-sources, we find differences which suggest reasons for the selection of one or the other according to the particular circumstances of the case.

If the Microscope be set up close to the window, and the mirror towards a clear sky, the condition of an unlimited expanse of light-source is fulfilled, provided the window-frame allows passage to all rays of light included within the outlines of the cone traced by the outermost rays incident upon the mirror to form the illumination. Thus, if *p m* and *p n* represent the outlines of a luminous cone touching the edges *a b* of the diaphragm aperture and based on the mirror A B, then the incidence is found by construction (in tracing back the angle of incidence equal to that of reflection) at *s* and *t*.

But from the concave mirror C D the lines of incidence are found at *s′* and *t′*, the central ray being the same for both mirrors (Fig. 5). If there be sufficient sky surface uniformly illuminated and nothing intervene between *s* and *t* to obstruct the passage of light, it is a

Fig. 4.

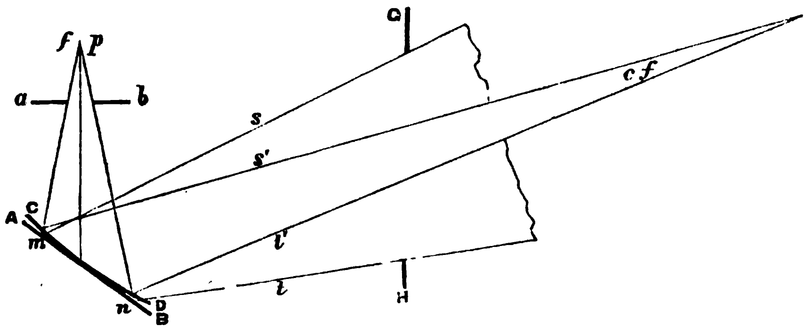
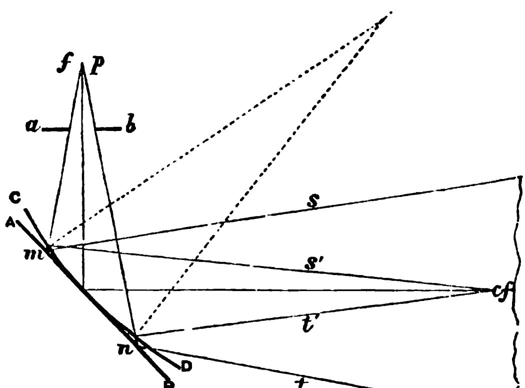


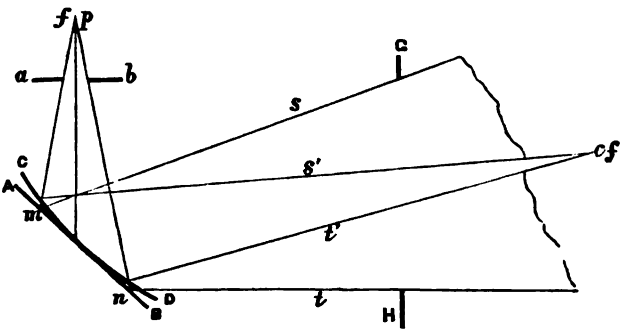
Fig. 5.



matter of indifference whether the incident rays converge at *s m*, *t n*, or diverge at *s′ m*, *t′ n*. But when anything intervenes to obstruct or occasion loss of light, then the form and position of the mirror surface becomes important, and that particular combination will act best which avoids the impediment, or the loss of light occasioned by it. For instance, if dark clouds occupy with bright clouds the expanse required for illumination with the plane mirror, the concave mirror disposed so as to receive rays from the bright cloud and reunite them in *p*, would give a maximum light; and

similarly the concave mirror will produce a more intense light whenever the light-source has a limited extent (e.g. flame of a lamp), provided that the source of light and the object stand to each other in the relations of conjugate *foci* (as in Wollaston or Brewster "condensers").

FIG. 6.



FIGS. 4-6, showing action of concave and plane mirror compared.
FIG. 4, Mirror inclined at 35°.
FIG. 5, " " 40°.
FIG. 6, " " 45°.
f p, Focal plane of object.
a b, Aperture of diaphragm.
C D, Concave mirror.
A B, Plane mirror.
s t, Converging beam on plane mirror reflected to $fp = 20°$.
s' t', Diverging beam on concave mirror reflected to $fp = 20°$.
Supposing sufficient extent of light-source (sky, e.g.), and sufficient mirror surface, the plane mirror gives an equal illumination with concave mirror.
N.B. The conjugate focus of concave mirror varies with inclinations of mirror towards axis of instrument.
The diaphragm aperture determines the angle of convergence within limits prescribed by extent of light-source and mirror surface.

It must then be accepted as a general proposition that the illumination of any and every single point in the field of vision is of necessity always effected by *converging* light. The illuminating rays cross each other at the plane of the object when the plane mirror as well as when any concave mirror or condensing lens is used. And it is inconceivable that such directions should be given (and called *excellent!* upon Sir D. Brewster's authority) as may be found in 'The Microscope,' by Jabez Hogg, 1854, page 51, as follows: "Only a portion of the object should be viewed at one time, and every other part excluded. The light which illuminates that part should be admitted through a small diaphragm (!)—*if in the day-time close a portion of the window-shutters*" (!). The customary manner of speaking of parallel or diverging rays as being employed to illuminate according to circumstances (!) the

field of vision, meaning thereby each constituent point of it, is equally opposed to the simplest law of optics.

With reference to the various lens combinations interposed in the course of the incident light, it is easy to show that their effect is exerted only *under special circumstances*, as has been shown of the form and position of the mirror. Thus, if we take Sir D. Brewster's condenser (Fig. 8), where F is a point in the plane of the

FIG. 7.

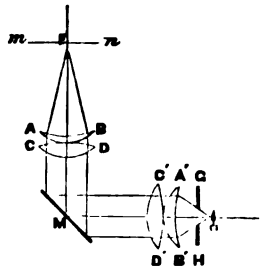


FIG. 8.

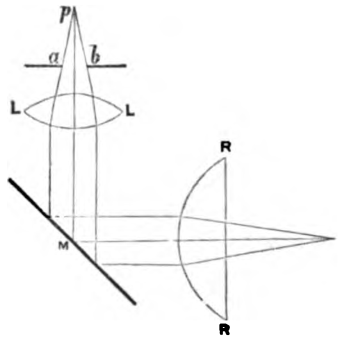


FIG. 8 (from pp. 95 N. and 1 S. 'Das Mikroskop'), to illustrate theory of action of *Cata-dioptric* illuminator.

p, Plane of object and focal point of illuminator.
a–b, Diaphragm aperture regulating the angle of convergence.
L, Lens emitting converging pencil.
M, Mirror.
R, Bull's-eye condenser.

FIG. 7, Condenser designed by Sir D. Brewster.

A B C D, Lens combination sending converging pencil on F focal point in plane of object *m n*.
A' B' C' D', Lens combination for collecting light from light-source and transmitting to mirror M.
G H, Diaphragm aperture.

In both diagrams the luminous source is practically the surface of the lens immediately under the plane of object, and *a b* is manifestly better placed than G H for regulating the size of illuminating pencil.

object, G H the diaphragm aperture which determines the size of the incident cone,* then A B, the last refracting surface of the combination, simply represents an area of light-source, and is in effect self-luminous, since the light received by the lens system A B C D is

* It should be noted that H G is a screen supplied with different circular apertures and "a variable rectilinear aperture," the image of the slit being thrown upon a lined object parallel with its lines. And a final recommendation is made by Sir David Brewster, which I here quote. "It would be desirable to have circular and rectilinear apertures of different sizes to be placed immediately *beneath* F, so as to allow no part of the field to be seen excepting that which is occupied by the object or part of it under examination." The action of such supplementary diaphragms would modify (beneficially) the incidence of light if the aperture were not so fine as to occasion diffractive effects. (!)

emitted from the surface of A B in rays variously converged upon the object; and whether the rays received by A B reach it by direct incidence or indirectly (that is, after previous reflections or refractions) does not signify, as there is here no question of the manner in which the rays incident from the original light-source are directed upon the mirror, neither any question of the extent of the light-source. The two sets of lenses A B C D and A′ B′ C′ D′ have obviously no other effect than to occasion various changes in the course of the rays during their transference from the light-source to the object. As before explained, the whole effect consists in producing an image of the flame in direct contact with the object; and in considering the question of intensity of illumination it must be borne in mind that an image of the light-source brought to the plane of object upon which the instrument is focussed, is by the operation of the lenses of the Microscope brought up to the eye. The brightness is thus increased, because the light is made by optical means to touch the retina, not because it is "condensed" on the object.

It may be laid down as a general principle that any plane below the diaphragm (i. e. section across the light-cone), or even the diaphragm aperture itself, may be taken as the illuminating surface, whatever changes may have occurred previously in the course of the incident rays from refraction or reflection.

Putting now the case where the magnitude of incident light-cone is not regulated by a diaphragm aperture, and where the interposition of a collecting lens brings about a greater convergence of rays, and under circumstances (where the aperture of light-cone is not determined by the mirror) a large illuminating cone: it is always possible to place the lens in such a position that its whole surface should deliver light upon the point *p*, Fig. 9. The effect produced in this case is the same as when light is reflected from a mirror large enough to subtend as a base the cone whose outlines are formed by prolonging the outlines of the cone delivered by the lens until they meet the mirror. The illumination given by the lens would be proportioned to its proximity or distance from the object; but an equal light would be gained by increase of mirror surface. It is obvious, however, that a practical advantage is obtained by the collecting lens when the light-source is of limited extent, and especially when—which is the more common case—both mirror and light-source are limited. Yet, as a matter of theory, the maximum of light that can be obtained by any "condenser" cannot exceed that which a sufficiently large mirror and expanse of light-source (sky light) would produce.

Thus it appears that an illuminating apparatus of whatever kind is efficient in two ways only. First, by equalizing the intensity of the rays over the whole area of illumination; secondly, by

increasing its angular convergence on the object. Any simple collecting lens will perform the same service as the most complicated lens combination if it have suitable focussing arrangements, and its refracting surfaces are so controlled by diaphragm apertures

FIG. 9.

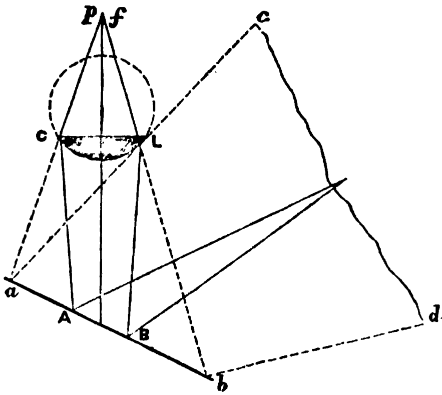


FIG. 9, to show action of plane mirror and collecting lens without diaphragm aperture.

P *f*, Focal plane of object.
C L, Collecting lens.
C P L, Illuminating cone emitted from C L, whose light is derived from the surface of mirror A B.

Its angle of convergence and specific intensity = that which the larger mirror surface *a b* reflects without intervention of lens, and supposing the light-source to have sufficient extent to give the incident cone *c a b d*.

N.B. It thus appears that, 1, where the angular convergence of illuminating cone depends on plane mirror reflections, the size of mirror and requisite extension of light-source set limits to its use; 2, that an artificial light-source of small extent, the reflection of which from mirror gives a diverging cone, is (within certain limits) more conveniently converged on the object by a collecting lens properly arranged.

as to exclude colour; a concave mirror being employed when the light-source is of limited extent. The magnitude of the incident light-cone will be in proportion to the proximity of the diaphragm to the object. Its focal point need not fall exactly on the object, though the maximum of light is attained when it is so focussed. But a diaphragm aperture, which, being too large or too near the object, allows an excess of light to fall on it, is disadvantageous; as also when the aperture bounds a light-cone to which the mirror offers an insufficient base.

To satisfy every condition the apparatus should in addition to the diaphragm *over* the last refracting surface * which regulates

* See the Handbook of Professors Nägeli and Schwendener, p. 97, paragraph 87.

the aperture of the illuminating cone, be supplied with the means of excluding light from any part of it. Many objects are best seen when central rays are excluded, others when oblique illumination is employed. To regulate the illumination according to requirement a second diaphragm is needed: a revolving disk or sector fitted over the first with a set of differently shaped stops to be rotated over the openings. Any arrangement may be introduced which suits the mechanical requirements of the instrument; but the diaphragms should be placed above the lens, and not, as is generally the case, beneath it.

In the foregoing observations the optical principles upon which the various apparatus for illumination of microscopic objects by transmitted light depend, have been indicated in general terms, which may be thus summed up:—

Whether concave or plane mirror, prism, collecting lens, or achromatic "condenser" be employed, the cross section of the illuminating beam shows a plane which is bounded either by diaphragm aperture, or by limits of reflecting or refracting apparatus, and which may be considered as self-luminous in relation to the object, inasmuch as each point of its surface conducts light from the primary source with the same illuminating power as that source, excepting the insignificant loss by reflection from the lens surfaces through which the light is made to pass. The size and position of the effective light-giving surface define the extent of a *converging* cone falling upon each point of the object, which, traced towards the Microscope, offers a diverging cone from each transparent point of the object to the objective. The aperture of the objective defines in its turn the basis of the diverging beam admitted into the objective, and therefore the brightness of the image formed. When diffraction pencils are occasioned by the action of the object, their course differs from that of the ordinary pencils, and the admission of such diverted pencils depends on increased aperture. The track of the ordinary and diffractive pencils can be observed as an image of the light-giving surface at the upper focal plane of the objective. And this method of examining the performance of the objective shows, amongst other things, the illusory character of the general belief that illumination is effected by parallel or diverging as well as by converging rays. This subject and its illustration by experiment and diagram is reserved for another opportunity.

The intensity of light transmitted by any kind of "condenser" cannot be greater than that which the original source yields. But by the production of an intermediate illuminating surface the light from the original and more distant source is brought nearer, and the convergence upon the object greater (under circumstances determinable at will) while the intensity is equalized over the whole illuminating surface.

Professor Abbe has given the following formula or theorem capable of general application for the solution of the several problems relating to intensity of illumination:—

"Leaving out of calculation any loss occasioned by reflection from the lenses of the microscope, the brightness of the completely or partially transparent parts of the object is exactly the same as that with which it would appear to the naked eye looking through a diaphragm aperture immediately in front of it, the size of which aperture corresponds with the area of the image of the light-giving source, as seen at the eye-point of the microscope: the object being supposed to be viewed in its magnified dimensions against the light of the primary source as a background.

"As direct corollaries from this theorem it results—1. That the brightness of the microscope picture can in no case exceed that with which it would appear to the naked eye. But that for each angular value of the image-forming pencil, whether limited by the objective aperture or by the area of illuminating surface, there is a given amount of amplification, *below* which the brightness of the image is always equal to that of the object as seen by the naked eye. And this amount of amplification is reached when the image at the eye-point has the same diameter as the pupil of the eye.

"2. The intensity of brightness increases with the increase of angular aperture of the objective, so long as that aperture is not as large as that of the illuminating cone. But when the objective aperture is larger than that of the illuminating cone (and this is the usual case), the brightness diminishes. This happens with all the higher amplifications.

"3. *Cæteris paribus*, the brightness of image is inversely proportional to the square of the linear amplification when the area of eye-point image is smaller than the pupil opening. Whether the amplification be obtained by a strong objective and weak ocular or by a weak objective with strong ocular, the amount of light with each amplification is the same. And all objectives whose aperture exceeds the maximum angular value of the incident light-cone transmit an equal amount of light when an equal amplification is obtained by using oculars which equalize the magnifying power. The appearances which seem to contradict these corollaries are explained by the circumstance that all differences of sharp and clear definition are unconsciously interpreted as differences of brightness." *

Finally, attention must be directed to the physiological conditions

* The above extract is quoted from Professor Abbe's article in vol. ix. of Schulze's 'Archiv für Mikr. Anat.,' entitled, "Contribution to the Theory of the Microscope," published in 1874. The theory above enunciated with its corollaries is confirmed by Helmholtz, and agrees exactly with the results stated in the treatise of Helmholtz on the capacity of performance of the Microscope translated by the present writer for the Bristol Naturalists' Society's 'Proceedings.'

of the perception of light. When looking through the Microscope at a given luminous surface (field of vision), the intensity of light transferred to the retina depends upon the conditions of its transmission. The arithmetical expression of this intensity is found in the ratio which the light cast on the retina by the Microscope bears to that cast on an equal surface of the retina when the same luminous surface is viewed by the unarmed eye. Professors Nägeli and Schwendener give in their book an exposition of this subject, of which the following is an abstract:—The intensity of light cast on the retina when a given luminous surface is viewed by the unarmed eye does not vary with the varying distance of the eye from the light, because the image formed on the retina becomes larger or smaller in exact proportion with the increase or diminution of the angular spread of the pencils emitted from each point of the object viewed. One might suppose that the same relation would continue when objects were viewed through the Microscope, that is to say, that the amplification of the Microscope image would rise and fall in corresponding ratio with the magnitude of the light-cone incident on the objective. If this were so, we should see every object as bright in the Microscope as with the naked eye. That is, the intensity of light (Lichtstärke) of the Microscope would equal unity. But the diameter of the Microscope image (and therefore also of the retinal image) increases with the rise of amplification in vastly greater ratio than does the angular spread of the light-cone incident from the object and transmitted by the objective to the eye.

In vision with the naked eye, taking the pupil aperture $= \frac{1}{10}$ or $\frac{1}{12}$ inch, and the distance of clear vision $= 10$ inches, the angular divergence of the pencil may be about half a degree. In vision through the Microscope, on the contrary, it may amount to 90° or 100° or over, according to the construction of the objective and its magnifying power. In this case the amount of light entering the eye through the Microscope from every point of the field is greater than the amount which the unarmed eye takes in the ratio of 100^2 to $(\frac{1}{2})^2$ or $200^2 : 1$. But this light is distributed over a retinal surface larger than that occupied by the retinal image of the object seen by the unarmed eye in proportion of the square of the linear amplification, which we will call m^2. The resulting brightness of field (which we will call v) is therefore represented by $v = \frac{200^2}{m^2}$, or, generalizing this formula, and setting ω for the angular aperture of the objective, and $\frac{1}{2}$ for that of the pupil, then $v = \left(\frac{\omega}{m}\right)^2$. Hence the light intensity is $=$ unity when $m = 2\omega$, but less than unity when $m > 2\omega$, which is the common case. Here it is assumed as understood that the incident light-cone is large enough to fill the whole aperture of the objective, a condition seldom realized. In

place therefore of the full aperture ω the angular aperture fixed by the diaphragm opening (we will call it δ) must be substituted, and then the formula becomes $v = \left(\frac{2\,\delta}{m}\right)^2$; that is to say, with the same illumination, the brightness of field will vary in inverse proportion of the square of the linear amplification. For example, make $\delta = 30°$ (magnitude of illuminating cone), and use amplifications of 240, 300, 360, 420, &c., and we get for brightness of field in the several cases $\frac{1}{16}$, $\frac{1}{25}$, $\frac{1}{36}$, $\frac{1}{49}$ respectively. Raising, however, the value of δ to 60° or 90° by increasing diaphragm aperture or employing a lens, the brightness will reach from four to nine times the intensity in the respective cases, provided always that the objective aperture admit cones of such angular incidence.

The above rough calculation is corrected in greater detail by the authors, with the final conclusion that the sectional areas of the corresponding light-cones (those, namely, of the final Microscope image, and of the incident light on the objective) are to each other as the squares of the numbers representing their respective magnitude. When, then, the light emerging from the ocular (at eyepoint) just fills the area of the pupillary opening, the corresponding cone of light entering the objective is therewith determined. For if the latter exceed the dimensions calculated on the above-stated relation of proportion, the excess of light could not be utilized. And, as the sectional area of a cone is always somewhat larger than the interior area of its "calotte," * we arrive at the conclusion that a luminous surface seen through the Microscope can under no circumstances possess greater intensity than when seen with the naked eye.

Since this paper was written the author has been enabled, by the courtesy of Mr. Crisp, to examine a simple Microscope made by Dollond (date ?) on the plan of Wollaston's instrument. The optical conditions are, however, changed by *removal of the diaphragm*, and by giving a sliding *vertical motion to the "condenser."* The distance of mirror from condenser when the lens is raised so as to bring its focus to the level of the object, is 4 inches: the distance between surface of lens and plane of object being then ·9 inch. The lens is worked to radius of ·5 inch, and has a front surface of ·5 inch. The diameter of mirror is ·7 inch, and being distant 4 inches from the lens, allows, when inclined at 45°, the reflection of a parallel beam of light to fall upon the surface of the condenser, occupying its full diameter. In this position, therefore, the light-cone thrown on the plane of the object has a radiant base of ·5 inch, its apex being distant about ·9 inch, and the outer rays have consequently considerable inclination to the axis. When the lens is moved down towards the mirror as far as the mechanical arrangement permits, the distance from object to lens is 1·4 inch, and from

* Because the light-intensity of the respective cones does not *exactly* bear the ratio of the squares of their respective angular magnitudes, but of the respective portions of interiors of spheres conceived to be described round the apex of each cone, on diameters drawn at equal distance from their apices (*calotten-fläche*). See pp. 76, 77, second edition of Professors Nägeli and Schwendener's Handbook, 1877.

thence to the mirror 3·4 inches. In this position, therefore, a parallel beam of incident light would focus below the object, but a slightly divergent incident light-cone coming from a near light source, would fall with conjugate focus on the object. Between these extreme positions the vertical movement of the condensing lens (½ inch) would afford various intermediate incidence of light rays. The absence of the diaphragm and the fixed distance of mirror render the mobility of condenser essential for regulation of light and disposition of conjugate focus.

The mechanical arrangements of this simple Microscope are specially worthy of notice, as indicating transitional phases in construction. The tube form of body and fixed distance of mirror are retained as in Wollaston's instrument—obviously the prototype of the "petit tambour" model so common in Swiss and French instruments. The absence of diaphragm no less clearly marks the fact that its function as a regulator of the magnitude of the illuminating pencil was not recognized, or at least not acted upon, as an optical principle to be taken advantage of in construction of the illuminating apparatus. On the other hand, a great advance in the general mechanical arrangements beyond those of Wollaston's instrument, is noticeable in the addition of a small traversing stage, with revolving object carrier, and of a "fine movement" screw to the stem and bar, carrying the simple or doublet lenses. Thus we find in Dollond's developments of the Wollaston instrument the same mechanical aids which characterize the modern stage movements of the compound Microscope with the exception of those introduced in the more complete arrangement of the sub-stage and movable mirror which followed the later practice of oblique illumination and the application of various accessory apparatus.

The main interest attaching to this instrument lies, however, in the attempt to develop the means of illumination upon scientific principle.

XXIX.—*Observations on Notommata Werneckii, and its Parasitism in the Tubes of Vaucheria.* By Professor Balbiani.*

(*See 'Proceedings,'* 11*th June*, 1879.)

PLATE XVIII.

I.—*Historical Summary.*

In the preliminary part of his 'Histoire des Conferves d'Eau Douce,' after describing the horn-like or tubercular excrescences which originate on the side of the filaments of the Ectosperms (*Vaucheria*), and constitute the male and female reproductive organs of these unicellular algæ, Vaucher adds, that "we must not confound these horns or swellings with another kind of corpuscle frequently met with on the Ectosperm, whose function was long unknown. It differs from the oogonia properly so called, in being larger and of varied form, though always enclosing a rounded black spot, which sometimes seemed to me double. Continuing to observe this black spot, I recognized it as the insect called by Müller *Cyclops lupula*. Apparently it lays its eggs on the tube of the Conferva, and causes a similar development to that called *gall* in plants." † In the

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EXPLANATION OF PLATE XVIII.

Parts of the Animal.

bo, mouth. *c c*, ciliated cavity. *ch*, external chorion. *ch'*, internal chorion. *c n*, nervous centre. *e*, stomach. *g c*, caudal glands. *g g*, gastric glands. *g r*, fatty globules arising from the destruction of the gastric glands. *g s*, salivary glands. *in*, intestine. *l*, superior lip of the buccal vestibule. *l'*, lateral lips. *m s*, stomachal mass. *o*, summer eggs. *o'*, their empty shells. *o''*, winter eggs. *od*, oviduct. *œ*, eye. *o r*, rotatory organ. *œs*, œsophagus. *o s*, segmental organs. *ov*, ovary. *ph*, pharynx. *t*, external integument with the subjacent cellular layer. *v b*, buccal vestibule. *v c*, contractile vesicle. *v g*, germinal vesicle.

Parts of the Plant.

b, branch bearing the organs of reproduction. *b a*, adventitious branches at the summit of the gall. *b a'*, adventitious branches of the base. *c a*, antheridian cell empty and open. *f c*, false septum. *g*, galls formed by the parasite. *o*, organs of sexual reproduction. *r a*, antheridian branch. *r s*, sporangiferous branch. *sp*, sporange. *x*, *x''*, points where openings of the parasitic pockets occur.

Fig. 1.—Tubes of *Vaucheria terrestris*, with a low power. They show at *o o* the reproductive organs, and at *g g* the capsules or galls inhabited by *Notommata Werneckii*, whose presence is indicated by the internal black point.

Fig. 2.—*Notommata Werneckii* (adult)—dorsal face.

Figs. 3, 4, and 5.—Cephalic extremity, in profile. These figures are intended to show some of the variations of form due to the contractions of this part.

Figs. 6 and 7.—Same extremity—ventral face. In Fig. 6 the buccal vestibule is represented widely open, in Fig. 7 it is half closed.

Fig. 8.—Posterior extremity. A summer egg is in the oviduct *od*.

Fig. 9.—Full-grown *Notommata*, its body distended by eggs nearly mature. In

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* Translated and *abridged* from 'Annales des Sciences Naturelles (Zoologie), vol. vii. (1878) No. 1.

† 'Histoire des Conferves d'Eau Douce,' 1803, p. 18.

explanation of his figures, Vaucher speaks throughout of these oogonia as galls inhabited by *Cyclops lupula*.

After Vaucher, Lyngbye * observed similar excrescences on *Vaucheria dichotoma*, without, however, seeing the parasite inside.

In 1827, Unger † also described and figured the parasitic swellings on *V. dichotoma*. Unger remarked that the forms described by Roth ‡ under the names *Conferva dilatata* var. *clavata* Rth., and *C. dilatata* var. *bursata* Rth., were only *Ectosperma clavata* attacked by the same parasite.

In 1833, Wimmer § showed animalculæ enclosed in the excrescences of a Vaucheria of undetermined species, but failed to recognize their nature. The excrescences he considered with Vaucher to be "galls." Dr. Valentin, who undertook their microscopic study, was equally unsuccessful, and only pointed out that the small bodies enclosed with the parasite in the capsules were eggs.

In 1834, Dr. Werneck examined some excrescences enclosing animalculæ on *Vaucheria cespitosa*, received from Professor Unger; and from a drawing which he made, Ehrenberg was able for the first time to establish their true nature, classing them with Rotatoria of his genus *Notommata*, and calling them *Notommata Werneckii*.‖

In 1836, Ehrenberg ¶ himself observed the excrescences on

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the centre is seen the black stomachal mass *m s*, surrounded by a circle of fatty globules arising from the destruction of the gastric glands.

Fig. 10.—Young *Notommata* during the free period of its existence.

Fig. 11.—Summer egg just laid.

Fig. 12.—Summer egg containing an embryo on the point of being hatched.

Fig. 13.—Winter eggs recently laid.

Fig. 14.—Reproductive organs of *Vaucheria terrestris* after fecundation.

Fig. 15.—The same organs after the destruction of the spore. A young *Notommata* is in the interior of the sporangiferous branch *r s*. A false septum *f c* is formed in the tube of the plant, not far from the branch which carries the reproductive organs.

Fig. 16.—Parasitic pocket or gall of *Vaucheria terrestris*, containing a female in the act of laying summer eggs.

Fig. 17.—Gall containing a female which has finished laying its winter eggs *o'*. The antheridian cornicule *r a* is entirely empty of its contents.

Fig. 18.—Old parasitic capsule formed at the extremity of a filament, and containing a great number of summer eggs in the act of hatching. At the base of the capsule, three young *Notommata*, recently hatched, are looking for an exit. The body of the female is destroyed, and only the black stomachal mass *m s* remains. *f c*, false septum in the tube of the plant, closing the passage on this side.

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* 'Tentamen hydrophytologiæ danicæ,' 1819, p. 82.

† 'Die Metamorphose der Ectosperma clavata Vauch.,' Bonn, 1827, and 'Ann. des Sc. Nat.,' 1828, xiii. p. 428, pl. xvi.

‡ 'Catalecta botanica,' fasc. ii. p. 194, and fasc. iii. pp. 183–4.

§ 'Uebersicht der Arbeiten der Schles. Ges. für väterl. Cultur,' 1833 (1834), p. 71.

‖ "Organisation in der Richtung des Kleinsten Raumes," 'Beitr.,' iii. 1834, p. 72.

¶ 'Die Infusionsthierchen als volkommene Organismen,' 1838, p. 429.

V. dichotoma and *V. racemosa*, which, however, only contained eggs which died before hatching. He succeeded, however, in extracting the embryo by breaking the shell, and observed among other characters, the eye, and the jaws with a single tooth.

Notwithstanding the interest of Ehrenberg's discovery, we find but few observations recorded during the succeeding forty years. In 1839, Morren found club-shaped excrescences on *Vaucheria clavata*, and within them the parasite and its eggs. Opening one of the cysts, Morren saw the animalcule, instead of coming out, bury itself in the tube of the plant. He took it to be *Rotifer vulgaris*.*

In 1840, Meyen found it no less difficult than Morren had done, to explain the introduction of the animalculæ into the tubes of the plant.†

In 1853, the late Professor Hofmeister, in conjunction with Professor Cohn, observed the filaments of a *Vaucheria* which had pushed out short lateral club-shaped branches, in each of which was a rotifer, which moved its cilia briskly. Hofmeister supposed that the animalcule had penetrated into the tubes by piercing the cellulose membrane without any damage to the plant.‡

In 1876, Dr. Magnus§ observed in *Vaucheria geminata* whose filaments were found floating in the ponds of the Thiergarten (Berlin), numerous galls almost always laterally placed, in each of which was a female of *Notommata Werneckii*, surrounded with eggs and newly-hatched young, which differed much in shape from the mother. Observing that some of the old and empty galls were perforated at the summit, Magnus supposed that the young had escaped from these openings, whilst the mother remained inside and soon died, exhausted by her numerous layings.

Kützing fell into a similar mistake with Roth, describing *V. geminata*, whose filaments bear parasitic galls, under the name of *Vaucheria sacculifera*, and mistaking the eggs of *N. Werneckii* for zoospores.‖

We see, therefore, that beyond the specific determination of the parasite, which we owe to Ehrenberg, we know very little of *N. Werneckii*, either as regards its mode of reproduction, or the details of its organization. This ignorance is doubtless owing to the fact that *N. Werneckii* is almost always observed by botanists, who naturally pay more attention to the plant than to its parasite.

* "De l'existence des Infusoires dans les Plantes," 'Bull. de l'Acad. de Bruxelles,' 1839, vol. vi. p. 298.

† Wiegmann's 'Archiv für Naturgesch.,' 1840, vol. ii. p. 79.

‡ 'Handbuch der Physiol. Botanik,' vol. i.; 'Die Lehre von der Pflanzenzelle,' 1869, p. 77.

§ 'Verhandlungen des botanischen Vereins der Provinz Brandenburg,' 18 Jahrgang, 1876, p. 125.

‖ 'Tabulæ phycologicæ,' vol. vi. p. 22, pl. lxiii. fig. 3.

In 1874, M. Maxime Cornu sent me some filaments of *V. terrestris*, on which he observed numerous swellings containing animalculæ which he recognized as Rotatoria. I saw that they were *N. Werneckii*, and eagerly proceeded to study this curious rotifer.

II.—*Organization of N. Werneckii.*

On examining the tubes of the *Vaucheria*, I distinguished on the greater number two kinds of laterally placed excrescences:—the one easily recognizable as the organs of reproduction, from their characteristic form (Plate XVIII., Fig. 1, *o*, *o*; Fig. 14); the other much larger, generally club-shaped, representing a kind of pocket, or elongated capsule, nearly at right angles to the principal filament, and having the same green colour (Fig. 1, *g*, *g*).

I opened one of these, and saw the parasite gradually disengage itself from the green matter. It was a blackish and extremely soft body, continually contracting and modifying its shape. At its centre was a large round spot with ill-defined edges, black and opaque with transmitted light (Fig. 9, *m s*); this spot represents the contents of the digestive tube, and is the *black spot* observed by Vaucher in the capsules of the Ectosperms. It is surrounded by a circle of colourless refractive globules, having all the characters of oil drops (Fig. 9, *g r*). Outside this was a wide, greyish, granular zone, forming the cortical layer of the animal. With a magnifying glass it appeared to be homogeneous, but under the Microscope was seen to be composed of numerous elliptical bodies, which were easily recognizable as nearly mature eggs (Fig. 9, *o*).

At intervals there appeared at opposite points of the body two short prolongations, one bearing, anteriorly, vibratile cilia; the other ending in a little tail with two triangular points (Fig. 9). These characters classed the animalcule with the Rotatoria, and finally, its red eye-spot and its situation in the tube of a Vaucheria proved it to be the *Notommata Werneckii* of Ehrenberg.

This summary description refers to the adult animalcule, ready to lay, when its body is much distorted and the internal organs so much modified as to be almost unrecognizable. To form an exact idea of its organization, it is advisable to take an adult animalcule whose ovary does not yet contain mature eggs.

Notommata Werneckii is a small rotifer not exceeding 0·30 mm. in length. The body is fusiform when elongated, the swollen portion being nearer to the anterior than to the posterior extremity, which is thinner than the former. It is divided, more or less distinctly according to its age, into seven segments, formed by transverse folds of the cuticle, and capable of being retracted one within the other (Fig. 2). The cephalic is the longest, the three middle,

which form the swollen portion, being nearly equal, and the three terminal ones diminishing successively in length. The last segment terminates in a foot or forked tail, formed of two small triangular points, which can be separated or brought together at pleasure. This segmentation becomes less and less distinct with age, in consequence of the distension of the body caused by the eggs, and finally it is transformed, as was said above, into a rounded sac, with two prolongations formed by the head and tail (Fig. 9).

Seen in profile, the body seems in its anterior part obliquely bevelled, at the expense of the ventral face. The dorsal face is prolonged into a projecting and protractile superior lip (Fig. 3), from the base of which descends on each side a fold of the external tegument, furnished with vibratile cilia at its edge, and uniting beneath with that of the opposite side, so as to circumscribe the opening of what is called the mouth, but which is more correctly the *vestibular orifice*, as it gives access to a cavity, at the bottom of which is the true mouth and the rotatory organ. To this cavity I give the name of *buccal vestibule* (Figs. 2, 6, *vb*).

The superior and lateral lips are soft and wonderfully contractile. The former especially is endowed with surprising agility, the movements being evidently tactile. (See Figs. 2–7, *l.*)

Inside the buccal vestibule is the *rotatory organ* (Figs. 2–7, *or*), which is the apparatus of locomotion and the organ of touch. It shares the excessive mobility of the surrounding parts. (See Figs. 3, 4, and 5.)

Ehrenberg and Leydig* differ in describing the rotatory apparatus, but it is certain that in *N. Werneckii* the cilia form, on the surface of the rotatory disk, an isolated bundle completely independent of the other cilia of this region.

I have never discovered the long threads which Ehrenberg, from Werneck's description, said existed at the sides of the mouth in the adult.

It is only at a very early stage that the animal uses its rotatory apparatus for progression, as it soon commences its parasitic existence in the tubes of *Vaucheria*, where it is of course incapable of swimming in the dense plasma.

In the free stage the young Notommata advance rapidly in the water, either gliding with a uniform movement or "*striding*" along after the manner of the rotifers; that is, by resting alternatively on the two opposite extremities of the body.

The energetic contractions imply a pronounced development of the *muscular system* which I have not been able to observe with sufficient accuracy to describe here.

The *digestive organs* are composed of the buccal cavity, of the

* See Leydig's "Ueber den Bau und die systematische Stellung der Räderthiere," 'Zeitschr. wiss. Zool.,' vi. 1855, p. 68.

pharyngeal bulb, the salivary glands, the œsophagus, the stomach, the gastric glands, and the intestine.

On the median line of the buccal vestibule, between the rotatory organ and the pharyngeal bulb, but nearest to the latter, is a longitudinal slit whose sides are so exactly in contact that it requires great attention to discover them. It properly represents the *buccal aperture* (Fig. 6, *b o*), which has been hitherto completely overlooked by observers, the cavity which we have called the buccal vestibule being commonly described as the mouth. When the vestibule is more or less shut, the mouth is hidden by the lips of the vestibule (Fig. 7, *l'*), but when open it is visible by the retraction of the lips (Fig. 6, *b o*).

The *pharyngeal bulb*, or *mastax* of the English naturalists, is a rounded pale mass, of homogeneous appearance, and without trace of the striæ caused by muscular fibrillæ so visible in several other Notommata (Figs. 3, 6, 7, *ph*). This absence of striation, an index of a feeble development of the contractile elements, is in keeping with the almost rudimentary condition of the jaws which the pharyngeal muscles move. The masticatory apparatus is far less complicated than in the greater part of the other species of the same genus. It most resembles *N. vermicularis* as figured by Dujardin.* Each jaw is composed of the small lateral branch called by Dujardin *scapus*,† which is articulated at its extremity with a small horizontal piece bent inwards, which constitutes the tooth proper (*acies* of Duj.). This tooth rests on a single median part, bifurcated anteriorily, which forms the support (*fulcrum* of Duj.).‡

Ehrenberg knew the extreme simplicity of the masticatory apparatus of *N. Werneckii*, through the drawings of Werneck, and remarked that the jaw had only one tooth. The feeble development of this apparatus is probably acquired, secondarily, by its parasitic life, and when the food (the vegetable plasma) is soft and easily divided, as the stronger and more complicated jaws of the free species are adapted to seize and eat hard and resisting substances.

At the posterior part of the pharynx are observable a pair of small, glandular, ovoid organs, disposed symmetrically, which are fixed by an attenuated extremity to the posterior edge of the pharyngeal bulb. From their forward position in the digestive tube, I consider them *salivary glands*, opening into the cavity of the pharynx by the attenuated part which represents the excretory passage. In the young individual these organs are comparatively large (Fig. 2, *g s*); in the old they are very small and driven into

* 'Histoire Naturelle des Infusoires,' 1841, pl. xxi. fig. 7.
† These pieces constitute the *mallei* of Ehrenberg.
‡ This is the *incus* of Ehrenberg.

the interior of the head by the mass of eggs which the body contains (Fig. 9, *g s*).

Behind the pharyngeal bulb, the alimentary canal constitutes a simple fusiform pocket which goes almost in a straight line through the cavity of the body (Fig. 2). The narrow part following the pharynx may be considered as an *œsophagus* (Fig. 2, *œs*), the median dilated region (Fig. 2, *e*) as a *stomach*, and the narrow elongated portion which terminates in the cloaca, as an *intestine* (Fig. 2, *in*). In the thin walls of the digestive tube I have not succeeded in seeing the large cells of which it is usually composed in the large species of Rotatoria.

The whole length of the digestive tube is furnished with very thin, long, vibratile cilia, causing a current towards the posterior part. After killing the animal by compression, I saw these cilia continue to move some time after death, whilst those of the buccal vestibule and rotatory organ ceased immediately, a proof of the influence of the will over the movement of the latter. In all adult individuals the stomach (Fig. 2, *e*) encloses a black pulverulent mass, the residue of digestion. This mass (the *black spot* of Vaucher) is in a state of slow rotation which continues under the action of the vibratile cilia. Small portions are detached from time to time, and are carried by the ciliary movement to the extremity of the intestine and expelled.

At the sides of the stomach are the two glandular organs called by Ehrenberg *pancreatic cæca*, and more appropriately by Leydig, *glands*, or *gastric appendages* (Fig. 2, *g g*). These glands are much larger in *N. Werneckii* than in other species of the same genus. They are convex at the external, and flattened at the internal surface, which is applied to the sides of the stomach from the termination of the œsophagus to nearly the middle of the gastric pocket.

These gastric glands are modified with age. Colourless, fatty drops are deposited in their midst, and their communication with the stomach becomes larger. They are finally drawn into the gastric cavity, where they are blended with a circular mass surrounding the granular black mass placed in the centre of this cavity. These changes are easily accounted for by considering that the gastric glands are placed in two folds of the wall of the stomach, which gradually unfolds with age.

The *excretory organs*, sometimes considered as an apparatus of aquatic respiration, are composed of a contractile vesicle placed in the posterior part of the body (Figs. 2, 8, *v c*) and of the two sinuous canals which open laterally into this vesicle (Figs. 2, 8, *o s*), and seemed to me to ramify in the thickness of the wall of the contractile vesicle before opening (Fig. 8, *v c*).

My observations on these, however, are as incomplete as those

on the *nervous system*. On the dorsal face of the body, above the pharyngeal bulb, I distinguished a pale, rounded, finely granulated mass, evidently representing the central nervous organ (Fig. 2, *c n*); but I could not see any of the peripheral nerves proceeding from it, and which Leydig has figured.*

The single median eye is placed, as in all *Notommata*, in the neck, and corresponds with the posterior border of the brain (Fig. 2, *œ*). It is composed of a small, refractive, spherical, crystalline lens set in a small mass of red pigment. In some *Notommata* the eye is fixed to the anterior part of a vesicle filled with opaque (calcareous?) corpuscles, placed behind the cerebral mass, to which it appears adherent. This is the *sacculus cerebralis* of Ehrenberg, of quite unknown functions, and is absent in *N. Werneckii*.

We must not confound with the preceding organ a small cavity on the dorsal face, in front of the eye, from which it is separated by the whole width of the brain (Fig. 2, *c c*). It seems to be bifid in its anterior half, and is furnished internally with very fine vibratile cilia, and contains a clear and transparent liquid. Its functions appear to be as obscure as those of the *sacculus cerebralis*. These problematical organs are frequent amongst Rotatoria, and are thought by some authors to be sensitive organs on account of their more or less distinct connection with the nervous centre.

In the posterior part of the body, in front of the caudal fork, are the two elongated organs general amongst Rotatoria, and which Leydig, on account of their general form, calls *club-shaped organs*. In our species they are short and fusiform, and do not reach beyond the last segment of the body (Figs. 2, 8, *g c*). Thanks to the observations of Leydig,† Cohn,‡ Grenacher,§ and Möbius,‖ we know that they are the glandular organs producing the glutinous substance which enables the animal to fasten its foot to surrounding bodies.

III.—*Reproduction*.

All the individuals which I observed were females. The ovary, in the form of an elongated sac, rises in the cavity of the body, beside the digestive tube, as far as the inferior part of the gastric glands (Fig. 2, *ov*). Its posterior part, contracted into the form of an oviduct (Fig. 8, *od*), opens, as in all Rotatoria, into the cloacal canal. Its structure is very simple. In a kind of granular stroma are numerous ovules, presenting the same degree

* 'Ueber den Bau,' &c., p. 24, pl. vi. figs. 16 and 17.

† Müller's 'Archiv,' 1857, p. 410.

‡ "Ueber die Fortpflanzung der Räderthiere," 'Zeitschr. wiss. Zool.,' 1859, vol. vii. p. 439.

§ "Einige Beobachtungen über Räderthiere," 'Zeitschr. wiss. Zool.,' 1869, vol. xix. p. 494.

‖ "Ein Beitrag zur Anatomie des Brachionus plicatilis," 'Zeitschr. wiss. Zool.,' 1874, vol. xxv. p. 111.

of development in the same individual. The vitellus, at first homogeneous and colourless, encloses a clear germinal vesicle, having itself a bulky Wagner's spot. Later on it becomes granular and yellowish, the germinal vesicle forming a clear rounded spot, and looking like a solid brilliant nucleus when treated with acetic acid. As the eggs approach maturity they are piled one on another in the ovary, mutually flattening each other. The distension they cause ends probably by rupturing the ovarian sac, for later on they are found free in the cavity of the body, immediately beneath the external integument. The animal then presents the rounded form of Fig. 9, with two short prolongations, one at the head, the other at the tail.

Like many other rotifers, *N. Werneckii* produces *summer eggs* and *winter eggs*, the former destined to be immediately hatched, the latter passing through the cold season, and only hatching the following year. They differ from each other from the moment they are laid, the summer eggs being smaller than the winter eggs (the former being 0·056 mm. by 0·042 mm., and the latter 0·062 mm. by 0·050 mm.). They present other differences in their contents, and the number and character of their envelopes. The summer egg has a clear, transparent vitellus, uniformly granular; a thin chorion constitutes the sole envelope (Fig. 11). In the winter egg, the vitellus is brown and opaque; it has a diffused, clear, rounded spot in its centre, probably due to the persistence of the germinal vesicle (Fig. 13). There are two envelopes separated from one another by a space filled with a clear liquid; the external one thicker (*ch*), forming a somewhat solid shell, and the internal one thin and membranous, closely applied to the vitellus (*ch′*).

Since Dalrymple's * discovery of the existence of small male individuals of *N.* (*Asplanchna*) *Anglica*, two opinions, diametrically opposed to each other, have existed among scientific men on the mode of development of summer and winter eggs. Some maintain with Huxley that the summer eggs alone require for their development the male element, whilst the winter eggs are produced without previous fecundation. Cohn † and others think, on the contrary, that the latter require sexual impregnation, whilst the former develop by virtue of an intrinsic fecundity (parthenogenesis). Cohn supports this opinion by the fact that in all the species where winter eggs are found, their appearance always coincides with that of the males, as in many Hydatinæa and Brachionæa; whilst in the whole family of Philodinæa, where these eggs are unknown, no males have been observed.

* "Description of an Infusory Animalcule allied to the genus Notommata of Ehrenberg," 'Phil. Trans.,' 1849.

† "Ueber die Fortpflanzung der Räderthiere," 'Zeitschr. wiss. Zool.,' 1856, vol. vii. p. 483; 1858, vol. xi. p. 293.

My own observations have led me to a different opinion to that of either Huxley or Cohn. As I have already said, all the individuals which passed under my notice during April and May were females. I do not conclude from this the absolute absence of males, as these may only appear in autumn. At the beginning of my observations it was exclusively summer eggs which were produced. Later on these eggs were mixed in increasing proportion with winter eggs; and finally, at the end of April and the beginning of May, nearly all the eggs were of the latter kind. Not only was the production of summer eggs very considerably diminished, but a great number remained sterile, or if an embryo was formed it died without hatching, even when it had arrived at an advanced stage, as shown by the eye spot visible through the envelope. These facts show the gradual exhaustion of the vitality of the germ in the non-fecundated summer eggs. As to the winter eggs, I conclude that the assistance of the male sex was not necessary to their production or development, not merely from the fact that no male individual was ever presented to my observation, but from the fact that seminal corpuscles were absent in the females extracted from capsules containing winter eggs. A final proof of the absence of males is to be found in the complete identity presented by all the summer eggs. We know, by the researches of Dalrymple, Leydig, Cohn, Gosse, and others, that the sex of the future embryo of the Rotatoria is indicated in the egg, by various characters, such as form, size, and colour, which differ in male and female eggs, but I have never remarked this in the species under observation, where all the summer eggs resemble each other, even in the smallest details.

Cohn * has raised the question whether the same female can produce, either at the same or different epochs, summer and winter eggs. He negatives it, claiming to have established that each female only lays eggs of one kind. He even thinks that, when in one species there are male eggs besides, the production of the three sorts of eggs devolves on three different kinds of females. My observations do not agree with the opinion of Cohn. *N. Werneckii* enables the point to be easily decided, as the females enclose themselves in separate capsules, in most of which I have found the two sorts of eggs mixed in variable proportions, from which I conclude, contrary to the assertion of Cohn, that one and the same female can produce the two sorts of eggs. The earlier layings of the year are composed nearly exclusively of summer eggs, whilst it is winter eggs which predominate in the latter.

In spite of their name, the laying of the winter eggs sometimes begins from the early spring. The name was founded on the fact that the eggs pass through the winter and only hatch in the fol-

* *Loc. cit.*, p. 431.

lowing spring. The name of "*durable eggs*" (*Dauereier*, Cohn), expresses better their physiological character, of opening only after a long period of repose.

Some days before hatching we can distinguish in the egg a well-formed embryo, and recognize the greater part of the organs. It is doubled upon itself, the head and tail curved on the ventral face, and in contact with one another (Fig. 12). Just before hatching it moves energetically, and turns round in all directions, vibrating its buccal cilia. These movements are to break the shell of the egg. The young animal escapes out of the opening, and soon afterwards the margins of the opening join so exactly that the envelope (absolutely empty) seems intact. The newly hatched young are vermiform and from 0·10 mm. to 0·12 mm. in length (Fig. 10).

IV.—*The Galls of Vaucheria terrestris.*

We must now consider the excrescences of the *Vaucheria*, and try to decide whether or not they ought to be assimilated to the galls produced by the action of some insects on phanerogamous plants.

V. terrestris is composed of tubular filaments, without internal septa, and filled with green matter. The organs of fructification, the antheridium and the sporangium, are borne on a small secondary branch rising at right angles from the side of the principal filament (Figs. 14, 15). This common branch is itself divided into two branches, the inferior of which is bent downwards in the shape of a horn, bearing the antheridian cell at its extremity. The superior, which is the continuation of the secondary branch, becomes club-shaped at the summit, and terminates in a transversal partition to form the oogone or sporangium.

Passing from the organs of reproduction to the excrescences inhabited by *N. Werneckii*, a simple comparison will show the complete morphological identity of the two. The parasitic cysts are only the persistent branches which bore the organs of reproduction, and which under the influence of the parasite have enlarged considerably and modified their form. We sometimes find young rotifers lodged in capsules which in no wise differ in form and size from the normal sporiferous branches (Fig. 15, *r s*), which removes all doubt concerning the nature of these productions.

As the parasite grows, the capsule which encloses it sometimes increases to five times its original bulk (Figs. 16, 17, and 18). At the same time the wall of cellulose thickens over all the periphery.

It is always at a very early age that the parasite is introduced into the plant, to pass there the remainder of its life. It is nourished exclusively on the *colourless* plasma of the capsule, as is seen by the entire absence of green colour in the digestive tube. This confirms

the observations of M. Chautard * and M. Felix Plateau,† that chlorophyll is not an assimilable substance.

The animalcule lays its eggs inside the capsule, without any regularity, either singly or in groups amidst the green matter. It then dies, leaving no vestige but the black mass (Fig. 18, *m s*), and between the laying and hatching of the eggs the capsule begins to decompose, the chlorophyll loses its homogeneousness (Fig. 18) and colour, and the eggs hatch from ten to fifteen days after being laid. The Notommata forthwith anxiously seeks an issue from the capsule.

We have seen that under the influence of the parasite the small lateral branches of *Vaucheria*, which bear the reproductive organs, instead of becoming atrophied, after the fulfilment of their functions, are hypertrophied to four or five times their normal size. I think that this arises from a stimulation, caused by the secretion of an acrid liquid, of the same nature as that which forms galls on phanerogamous plants, from the bite of insects, which introduce into the plant a liquid secreted by the salivary glands. These glands exist also in *Notommata*, at least I so consider the appendages of the digestive tube which open into the pharynx (Fig. 2, *g s*) Their relatively considerable size, compared to that of the organs to which some authors have attributed an analogous signification in other rotifers,‡ seems to indicate that they are destined to fulfil special and important functions in this species. These glands are also largely developed in the gall insects.

The parasitic excrescences on *Vaucheria* present another analogy with certain galls of the higher plants, in being the seat of a vegetative development which gives rise to the formation on different points of their surface of filaments filled with green matter. They are rarely found at the base, the summit being their more usual position. In the latter case, the upper part of the capsule begins to flatten, and to take an angular form; then at each of the angles a protuberance is formed, into which the plasmic matter penetrates (Fig. 16, *x x*). The capsular wall becomes considerably thinner at the culminating point of the protuberance, which continuing to elongate becomes a green filament (Fig. 17, *b a*), which is often many times the length of the capsule. Some bifurcate, some curve upwards like horns, and others take a horizontal or oblique position.

It frequently happens that instead of throwing out filaments the excrescence becomes perforated at its summit, thus forming a communication between the inside of the capsule and the surrounding

* 'Comptes Rendus,' 1873, vols. lxxvi. p. 103, lxxvii. p. 597.

† 'Recherches sur les Phénomènes de la Digestion chez les Insectes,' 1874, pp. 56, 119.

‡ 'Zeitschr. wiss. Zool.,' vol. vi. p. 73; Cohn, ibid., vol. vii. p. 475; Möbius, ibid., vol. xxv. p. 110.

liquid (Fig. 18). The young Notommata sometimes make their escape through this opening. The proof that the parasites do not themselves make the opening, as might be supposed, is that the capsules are often found perforated whilst still enclosing unhatched eggs.

The filaments at the base of the capsules (Figs. 16, 17, *b a'*) are formed in the same way. In this case also openings are sometimes formed (Fig. 18, *x''*) for the escape of the animal. Sometimes the antheridian tube itself at the base of the capsule, with its open extremity, serves as the exit (Fig. 17, *r a*).

Sometimes the young animals penetrate into the principal filament and reach another capsule which has an opening by which they can pass out. Their passage is, however, sometimes barred by the false septa (Figs. 15, 16, 18, *f c*), which are formed with such facility in the filaments of *Vaucheria* wherever there is a lesion, a septum of cellulose on either side isolating the part affected and preventing it spreading to the sound parts.*

Gradually the capsule becomes empty of animalculæ, and various Infusoria invade it and complete the destruction of the green matter.

The young Notommata move about very quickly when free in the water. They take no food during this period of free life, and soon return to the plant, never again to quit it. This re-entrance is effected through the various openings of the capsules which I have just described, from which they pass into the young green branches. Thus is explained their introduction into the tubes of *Vaucheria*, which was an enigma to all observers, with the exception of Dr. Magnus.

I will now speak of the destiny of the winter eggs. As we have seen already, they began to be laid in April, at first with summer eggs, then alone. About the middle of May, the laying of summer eggs had ceased, and the capsules contained only winter eggs. They were in much greater number than the summer eggs. In spite of all my care the *Vaucheria* died, but the eggs remained unaltered in the capsules, presenting no sign of development during the summer, autumn, and first half of winter. Unfortunately my observations were interrupted, and at the end of March I found all the eggs had hatched. This hatching must have taken place at the end of winter or beginning of spring, and the young had probably perished from want of food, as I found none in the water.

This interesting animalcule is not the only species of the genus *Notommata* parasitic on an Alga. Ehrenberg has made us

* See Hofmeister, 'Handbuch der Physiol. Bot.,' vol. i. p. 76, and Hanstein, 'Lebensfähigkeit der Vaucheriazellen ('Niederrh. Ges.,' Sitz. V., 4 Nov. 1872, and 'Bot. Zeit.,' 1873, p. 697.

acquainted with *N. parasita*, which inhabits the spheres of *Volvox globator.** Another species, *N. Petromyzon*, lives also in *Volvox*, often in company with the preceding.†

After Ehrenberg, *N. parasita* was the object of interesting observations by John Williams,‡ Gosse,§ and Ferdinand Cohn,‖ who discovered the male smaller than the female, and destitute of digestive organs, like all the males of the Rotatoria. Cohn proved also that *N. parasita* lays three kinds of eggs. 1st, numerous summer eggs with smooth envelope, which give origin to females; 2nd, eggs similar to the preceding, but smaller, whence issue males; 3rd, winter eggs in fewer number, but larger, and with an envelope bristling with short spines.

I will close with the following *résumé* of the principal results of my researches.

Notommata Werneckii presents two periods in its existence, one free, the other parasitic in the tubes of *Vaucheria*. In each of these two phases of its existence it takes a very different form. In the first it is elongated, vermiform, and divided into very distinct segments externally; in the second, in which it attains maturity, it is dilated, sacciform, very contractile, and without segmentation.

To these external changes correspond important modifications in the internal organs, characterized chiefly by the enormous development of the ovary and the atrophy of the appendages of the digestive tube (the salivary and gastric glands).

Like many other Rotatoria, it lays two sorts of eggs—summer and winter eggs, distinguished by their structure no less than by their mode of development.

The same female can produce either summer or winter eggs exclusively, or a mixture of the two kinds in the same gall of *Vaucheria*.

The winter eggs are produced in the spring; their laying commences later and is prolonged longer than that of the summer eggs: the latter develop immediately, while the former pass through the winter, and only hatch in the following year.

I have not observed any males, and on the other hand I have never found any spermatozoids in the females, from which I conclude that the winter eggs, like the summer eggs, develop without previous fecundation.

The galls of *Vaucheria*, in which *N. Werneckii* lives and is

* 'Die Infusionsthierchen,' 1838, p. 426, pl. l. fig. 1.

† *Op. cit.*, p. 427, pl. l. fig. 7.

‡ "On the occurrence of Parasitic Rotifera in *Volvox globator*," 'Trans. Micr Soc.,' 1852, vol iii. p. 129.

§ "On the *N. parasita* inhabiting the spheres of *Volvox globator*," ibid., p. 143.

‖ "Bemerkungen über Räderthiere," 'Zeitschr. wiss. Zool.,' 1858, vol. ix. p. 291.

reproduced, are due to a hypertrophy of the branches of the plant, which bear the organs of fructification. They differ from galls, properly so called, which develop on the higher plants, in being pre-existing parts, which have simply undergone an increase in bulk, under the action of the parasite. This exaggeration of the vegetative functions is also often shown by the formation of adventitious branches at different points of the surface of the gall.

The exit of the young Notommata born in the galls, and its re-entry into the tubes of *Vaucheria* to form new galls, is effected through the openings which are spontaneously produced at the summit of the adventitious branches. They also sometimes make use for the same object of the small projection or male organ of reproduction, which persists at the base of the capsule in the form of a tube open at its two extremities.

RECORD

OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.,

including Embryology and Histology generally.

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Nucleus in Blood-corpuscles.*—Upon reading some months ago Böttcher's demonstration of a nucleus in the mammalian blood-corpuscle after bleaching by corrosive sublimate and alcohol, it occurred to Dr. W. T. Belfield, of Chicago, that the asserted nucleus might be artificial, due to coagulation of albumen and extraction of water by the reagents used. It seemed that if bleaching alone were to be accomplished the same results should follow bleaching by other methods.

With this idea he procured specimens of fresh blood from man, the dog, rat, and turtle, exposed the corpuscles to the action of various bleaching agents—chlorine, sulphurous acid, acetic acid, a freezing temperature—then, when the colouring matter had been removed, he immersed them in weak solutions of anilin and carmine, and mounted them in distilled water. He was careful to produce as nearly as possible identical effects upon all the specimens treated by each reagent, using the same solutions for the same periods upon them all. By each method nuclei were clearly demonstrated in the turtle's blood, but in no other specimen was there any differentiation of colour. It is true that some mammalian corpuscles after prolonged immersion in the colouring fluid showed staining, but that staining was invariably uniform from centre to circumference, proving conclusively the absence of a nucleus so far as carmine staining can prove anything.

On these observations he bases a strong suspicion that the alcohol and corrosive sublimate used are responsible for the appearance of nuclei in corpuscles treated by Böttcher's method. This suspicion receives support from recent discoveries as to the structure of nuclei. In the July number of the 'Quarterly Journal of Microscopical Science' Dr. Klein relates a series of observations, as a result of which he affirms the nucleus to consist of a fibrillar network, imbedded in which is a ground substance; that this intranuclear network is continuous with a similar intracellular network; that nucleoli are merely the thickenings and shrivellings of these fibrils. The natural shrivelling effect of alcohol might readily produce a pseudo-nucleus in a blood-corpuscle from condensation of this intracellular network.

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 238.

Division of Cartilage Cells.*—In a short paper on this subjec Dr. W. Bigelow states his disagreement with Butschli's view that the division of the cell-body always goes hand in hand with that of the nucleus, and that the common case of a single cell with two nuclei is not an instance of commencing division. Bigelow's observations on the cartilage of all classes of Vertebrata lead him to the opinion that division of the nucleus always precedes that of the cell-body. He finds, in fact, cells with constricted (biscuit-shaped) nuclei, cells with two nuclei which are considerably larger than the neighbouring uninucleate cells, cells with two nuclei and a faint partition wall. In no case was a septum seen before the division of the nucleus was completed.

Amongst the ordinary cartilage cells of the sclerotic of amphibia and fishes were found some of especially large size, separated from surrounding cells by a great thickness of ground substance, which often exhibited concentric striation, and was stained with gold chloride. They often contained two or three nuclei, and were of very irregular form. Their protoplasm was stained red with gold chloride, instead of bluish like the other cells. The surrounding cells were often arranged radially around these large cells, of the origin and significance of which the author proposes to treat in a future communication.

Final Changes in Meckel's Cartilage.†—The process of retrogressive metamorphosis undergone by Meckel's cartilage in mammals has been studied in the pig by Dr. Baumüller, of Würzburg, who sums up his results as follows:—

After previous calcification of its intercellular substance, the posterior portion of the cartilage undergoes degeneration by fibrous metaplasis, this process extending from the tympanic cavity to about the middle of the alveolar portion of the mandible. Next, an increase in size of the hinder half of the remaining part takes place, connected with changes of form produced chiefly by the growth of the mandible. The most important of these changes are the constricting off of small pieces, which, enclosed by the lower jaw, contribute to its increase in size, by their subsequent ossification.

The second step in degeneration consists in the ossification of the remainder of the cartilage, with the exception of the symphysis, where, finally, the same process of fibrous metaplasis takes place, to which the disappearance of the hinder part of the cartilage was due.

Histology of Nerve-fibre.‡—B. Rawitz comes to the conclusion that the constrictions observed by Ranvier are formed, in the living organism, by a circle of pale substance, which surrounds the axis-cylinder and destroys the continuity of the medulla; that the "double contour" represents the whole of the medullary sheath, but is not to be made out in the fresh state; it surrounds the axis-cylinder. The crimped appearance observed by Lautermann is due to the breaking up of the nerve-fibre.

* 'Arch. f. Mikr. Anat.,' xvi. (1879) p. 458.
† 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 466.
‡ 'Arch. f. Anat.' (His and Braune), (1879) p. 57.

Microscopical Phenomena of Muscular Contraction.*—The microscopical phenomena of muscular contraction have recently been studied by Professor Th. W. Engelmann, of Utrecht.

During the contraction of the transversely striated muscular fibres there are produced, parallel with the changes of form of the muscular elements, changes in the optical properties of the isotropic and anisotropic layers.

These changes are of an opposite nature in the two layers, the isotropic stratum in its totality becoming more and the anisotropic less refractile.

In consequence, at a certain degree of contraction, the fibre seen by ordinary light may appear homogeneous without appreciable transverse striæ—the stage of homogeneity or of transition.

If the contraction is carried further, the transverse striæ corresponding to the isotropic disks reappear.

At any given phase of the process of contraction, consequently even in the transition stage, the isotropic and anisotropic substances may be recognized by means of the polarizing Microscope as well-defined and regularly alternating layers. They do not, at the time of contraction, exchange their respective places in the muscular compartment (i. e. that portion of the fibre included between the middle of the isotropic layer and that of the next).

The thickness of both layers decreases during contraction, that of the isotropic layer much more rapidly than that of the anisotropic. The total volume of each compartment does not vary sensibly during contraction.

The anisotropic layers increase in volume at the expense of the isotropic, as during contraction liquid passes from the latter to the former.

Development of the Olfactory Nerve and Olfactory Organ of Vertebrates.†—In the course of an investigation into the development of the cranial nerves of the chick, by Dr. A. Milnes Marshall, certain facts came to light indicating that the olfactory nerve, instead of being, as usually described, a structure differing totally in its mode of origin from all the other nerves in the body, in reality "exactly corresponds in mode of development and in appearance with the other cranial nerves, and with the posterior roots of the special nerves."‡ A further paper by Dr. Marshall gives the results of further investigations on this point; it deals also with some features in the development of the vertebrate olfactory organ and with certain questions of a more general nature affected by the conclusions arrived at. The more important conclusions, as regards the development of the olfactory nerve, are stated in the following propositions:—

(*a*) The olfactory nerves do not arise from the cerebral hemispheres, but from the single unpaired forebrain.

* 'Arch. Néerland.,' xiii. (1878) p. 437.

† 'Proc. Roy. Soc.,' xxviii. (1879) p. 324.

‡ 'Proc. Roy. Soc.,' xxvi. p. 50, and 'Q. Journ. Micr. Sci.,' xviii. (1878) pp. 17–23.

(b) There is no trace of an olfactory lobe in the early stages of development of the olfactory nerve.

(c) The olfactory nerve is a primary nerve comparable to the segmental cranial nerves.

The facts recorded concerning the development of the olfactory nerve and olfactory organ, point towards the same conclusions as the morphology of these structures, viz. that the latter is the visceral cleft, that the former is the segmental nerve supplying that cleft in a manner precisely similar to that in which the hinder clefts are supplied by their respective nerves, and that the Schneiderian folds are gills; conclusions which, if accepted, will considerably simplify our conception of the segmentation of the vertebrate head.

B. INVERTEBRATA.

Digestive Ferments of the Invertebrata.*—The paper of Dr. Krukenberg (of Heidelberg) on this interesting subject is reviewed in the 'Archives de Zool. Exp.'

In the most lowly developed forms (*Myxomycetes* and *Porifera*) there are digestive ferments, of which the best developed is the peptic; in most *Echinoderma* the formation of the ferment is not fully localized, and it seems possible that the nutriment may in them undergo ferment action outside the intestine; the liver of the *Asterida* is completely analogous to that of the *Arthropoda* or *Mollusca;* an analogous gland has been noted in the Holothurian *Cucumaria planci*, and in the Echinid *Toxopneustes lividus* and *T. brevispinosus;* in some *Vermes* the thryptic ferment (isothrypsin) is different to that of the *Vertebrata*, *Arthropoda*, and *Mollusca*, though probably identical with that of the *Asterida;* the hepatic follicles of *Aphrodite* have not this function; and it appears that there is nothing in the *Invertebrata* similar to the "stomach" of the *Vertebrata*.

Mollusca.

New Facts in the Anatomy of Molluscs.†—Dr. H. von Jhering contributes a short note on some recent discoveries he has made in the anatomy of molluscs.

He states that in the *Nudibranchiata*, urticating organs (Nesselelemente) occur, sometimes having the form of simple rods, as in Turbellaria, sometimes having the complicated structure of a Cœlenterate thread-cell. They arise invariably in the interior of ectodermal cells, and are formed in an urticating sac (Nesselsack), a structure surrounded with strong muscular walls, and situated at the extremity of the dorsal papillæ. In many genera this sac is prolonged at its proximal or hinder end into another, thin-walled sac, which is in close contact with the prolongation of the alimentary canal extending into the papilla: in many cases, even, the two run together, thus establishing a communication between the alimentary processes and the urticating sacs. In these same genera, also, each alimentary process opens externally by a small aperture at the apex

* 'Arch. Zool. Exp.' (Lacaze-Duthiers), vii. (1878) No. 3, p. xxxi.
† 'Zool. Anzeiger,' ii. (1879) p. 136.

of its papillæ, so that, besides the anus, the gut has several dozen external apertures, of use, probably, in the ingestion of water.

In *Pleurobranchæa*, another curious arrangement was found, namely, a duct opening in front of the gill, and placing the surrounding water in communication with the auricle of the heart. There is also a duct running alongside the kidney, and, as in *Doris*, placing the pericardial cavity in communication with the kidney.

Generative Organs of the Cephalopoda.*—Dr. Brock points out how little is really known as to the characters of these structures, with the exception, of course, of those two remarkable points which have long attracted the attention of naturalists—the spermatophore and the hectocotylus.

The male organs are highly differentiated, and consist of the seminal gland, together with an efferent apparatus, which is made up of several parts, and has various accessory organs, of remarkable structure and unknown function, connected with it. Of all the curious points, perhaps the fact that—so far as is yet known—there is no Cephalopod in which the efferent duct is directly connected with the testis, is the most striking, although there is a very close analogy between this arrangement and that which obtains in the females of the Vertebrata. The testis is ordinarily tubular in structure; the efferent portion consists of a long canal, which is divided into a thinner and a thicker portion; the latter is probably glandular in structure, and is in function connected with the formation of spermatophores (*vesicula seminalis*—Cuvier); the third portion is only well developed in the Decapoda, and received consequently no name from Cuvier, who busied himself most largely with the anatomy of *Octopus*. Dr. Brock proposes to call it the *vas efferens*. With this longish duct is connected the prostate and a cæcal sac; it leads into the sac for the spermatophores. This organ, perhaps most commonly known as "Needham's pouch," has had various functions assigned to it; it ordinarily forms a wide flask-shaped receptacle, which, in the Decapoda, opens into the mantle cavity by a wide neck, and in the Octopoda into an elongated muscular penis, which likewise floats freely in the mantle cavity. The arrangements found in *Sepia officinalis*, *Loligo vulgaris*, *Sepiola Rondeletii*, *Eledone moschata*, and *Octopus* are then described in detail, as are also the female organs of the same forms. As to these, the arrangements of the Octopoda are simpler than those of the Decapoda, and the same, it may be observed, applies to the male organs; the former have two symmetrical oviducts, but only one pair of accessory glands, while in the Decapoda there are a number of accessory glands, but only one—the left—oviduct. The large flask-shaped nidamental glands seem to be found in all Decapoda; the glands accessory to them are compact (*Sepiola*), or are formed of two symmetrical halves, connected by a narrow isthmus (*Sepia*), or of two separate glands (*Loligo*); and the orifices of these glands are so arranged that their secretions must mix, if both sets secrete at the same point of time.

Histological examination reveals the fact that not only can two

* 'Zeitschr. wiss. Zool.,' xxxii. (1878) p. 1.

portions be made out in the so-called vesicula seminalis, but that the epithelium of the whole glandular tract is of the same character throughout; this points to the physiological similarity of the secretion, and to the generalization that, howsoever greatly these glands may vary in external characters, they form histologically and physiologically a *single* glandular organ, the function of which is the formation of spermatophores. The cause of the variations in form appears likewise to be due to the formation of these bodies. In the female Decapoda the presence of the accessory nidamental glands reveals the existence of two sets of organs. Dr. Brock is of opinion that not only is the glandular epithelium of the nidamental gland exactly similar in its primitive condition to the epithelium of the accessory male glands, but that whatever changes do obtain never exceed the limits of individual modification. When the organ is in function, the epithelium becomes changed in character; in the male there is the formation of cells in great quantity; the separate cells are smaller, and vary in form. In the nidamental glands the cells become arranged in two rows, the upper ones ciliated, and the lower developing rod-shaped and regular elements, in the protoplasm of which a number of vacuoles appear. At first sight the differences in the water canals which connect the genital capsule with the renal sacs are such as to lead to the supposition that they are homologous structures; but if we consider that the thin pouch of the ovary of the Decapoda only differs from that of the Octopoda by the absence of a muscular layer, we shall see that the differences between the firm canals of the one and the lacuna-like canal spaces of the other group may be well referred to this cause. In the opinion of the author, what is now seen of the water canals is but the remnant of a more extended system, which he hopes to be able to trace out in the *Nautilus*.

Observations on the Organization of Solenopus.* — *Solenopus nitidulus* was first found by Koren about thirty years since, and subsequently by Professor M. Sars, by both of whom it was considered to be a mollusc, though they were not able to make a thorough examination. Dalyell, however, in the 'Powers of the Creator,' refers it to the Vermes.

Koren and D. C. Danielssen having obtained numerous specimens of different species, have made more extended investigations into the organization of the animal, of which a brief preliminary description (without figures) appears in the 'Archiv for Mathematik og Naturvidenskab' of Christiania, 1878. They decidedly confirm the reference of *Solenopus* to the Mollusca, but as it differs considerably from previously known molluscs, they have not been able to bring it under any of the established orders of Mollusca, although it may well be referred to the great subclass Opisthobranchiata of Milne-Edwards. They have accordingly formed for it a third order of that subclass, which they call Telobranchiata,† because the branchiæ are situated at the hinder extremity of the animal.

The Telobranchiata are naked marine animals, with more or less

* Translated by W. S. Dallas, in 'Ann. and Mag. Nat. Hist.,' iii. (1879) p. 321.

† From τέλος, end, and βράγχια, gills.

worm-like bodies. They are hermaphrodite, and have neither tentacles, eyes, radula, or jaws. The foot is long and narrow, and can be completely concealed by the mantle. The branchiæ, which are placed at the posterior extremity of the animal, are retractile. Heart with a pretty well developed vascular system. Generative organs situated along the back, above the stomach and intestine. Nervous system composed of an œsophageal ring with one cerebral and two pedal (infra-œsophageal, Tullb.) ganglia.

Family 1. *Solenopodidæ* K. and D.
(*Neomeniadæ* Jhering.)

Along the ventral surface a furrow, within which the long narrow foot is concealed. Branchiæ filiform.

Genus 1. *Solenopus* M. Sars, 1868.
Vermiculus Dalyell, 1853. *Neomenia* T. Tullberg, 1875.

Body cylindrical, with filiform branchiæ at its posterior truncated extremity. Above the branchial cavity in the posterior margin of the mantle a genital pore, and in the bottom of the branchial cavity an anal orifice. Buccal mass, thick, muscular, capable of being completely covered by the mantle which is covered all over with diversely formed calcareous spicules. Along the ventral surface a furrow in which the foot is concealed.

Six new species, in addition to *S. nitidulus* M. Sars, are described, viz.:—*S. affinis*, *S. Dalyellii*, *S. incrustatus*, *S. margaritaceus*, *S. borealis*, and *S. Sarsii*.

Organ of Bojanus in Anodon.*—Dealing with the view that the blood of the Lamellibranchiata becomes intermixed with water in the kidney (for such the "organ of Bojanus" is), Mr. Marcus Hartog points out that this can hardly be so, and that the true function of the water which enters its canal is that of flushing the renal ducts filled with what is now known to be, on the whole, solid excreta (Lacaze-Duthiers). The author points out that the foot is provided with a number of orifices without any rigid elements adapting them to resist compression, and with a supply of cilia which work inwards; the water which thus gains ingress must, on the contraction of the foot, pass away partly by its pores, partly through the "vena cava," and partly through the pericardium, whence it must escape through the kidney, which, as is well known, has an orifice into the pericardium; it is further pointed out that the cilia of the renal canals work towards the exterior, and that the external orifice is so arranged as to prevent water passing in from without.

Molluscoida.

Development of the Salpidæ.†—The question whether these interesting forms do or do not exhibit true alternation of generation is, curiously enough, bound up with the history of the development of their testes. According to one of the few naturalists who have

* 'Journ. Anat. and Phys.' (Humphry), xiii. (1879) p. 400.
† 'Zeitschr. wiss. Zool.,' xxx. (Suppl.) (1878) p. 275.

observed them, Mr. W. K. Brooks, of America, these organs are developed from the remarkable aggregation of cells, which, as containing fat in large quantities, has been called the *elæoblast*, found at the hinder end of the so-called fœtal or solitary form. With this view Professor Salensky disagrees; by the older, and indeed by the majority of naturalists, it has been held that the testes are developed at a later period than the ovary; in an early stage of the development of the "chain-Salpæ" there is found at the hinder end of the body an aggregation of cells; later on this commences and continues to grow forward, and, investing the hind-gut, forms a testicular layer, from the lateral portions of which the testes are developed, while its superior and inferior portions take no part in the formation of the testes, and in all probability disappear altogether. According to Professor Salensky's observations this organ has no relation to the elæoblast, as Brooks supposed that it had. What relation has this mode of development to the question of alternate generations? And, firstly, as to one striking peculiarity, which is this: the ova of the chain-Salpæ attain a comparatively high degree of development before the chain breaks free from the mother. This is an arrangement altogether unlike that which obtains in other forms that present this method of generation, and has led to the view that the solitary *Salpæ* are females, but that their ova are developed in the chained forms to which they give rise.

The chained forms are, according to this view, males, and the part homologous to the elæoblast is that which gives rise to the testes; but as Salensky does not regard this view of the origin of the ovaries as correct, and believes that he has shown that the testes have no homologous relation to the elæoblast, it follows that he looks upon the generation of these forms as being truly of the alternate mode.

On comparing these *Salpæ* with allied forms, a very great similarity is found to obtain between them and *Pyrosoma*; in this latter the ovum gives rise to a "cyathozooid" (Huxley); this develops by gemmation from its "stolo prolifer" the ascidiozoids, which are, like all *Ascidiæ*, hermaphrodite; the mother-form or "nurse" gives rise to an ovarian tube, which passes into the daughter-forms, and there produces ova; the only difference between them lies in the fact that *Pyrosoma* first gives rise to four ascidiozoids only, and that these undergo further gemmation; in the *Salpæ* there is nothing that is analogous to this.

Leaving the other forms of which the author treats, and merely indicating that he regards the aggregation of cells found in the tail of *Doliolum* as intermediate between the chorda of the Ascidian larva and the elæoblast of the *Salpæ*, we would note that he considers this last-mentioned organ as being obviously of greater morphological importance than a mere store of nutrient material, and as being provisional only; if this view be just, there is no obstacle to prevent our regarding the solitary form of *Salpæ* as exactly similar to the "nurse-form" of *Doliolum*, and, speaking more generally, we find that the "nurse" of the *Salpæ* corresponds to the larvæ of other

Tunicata, and is only a more or less modified form of the primitive type of larva.

Affinities of the Polyzoa.—The subject of Professor Allman's Presidential Address to the Linnean Society, on May 24, was, "Recent Progress in our Knowledge of the Endoproctal Polyzoa," in the course of which he stated that whilst still supporting the molluscan affinities of the Polyzoa as the most strongly marked, yet at the same time he could not overlook the fact that recent research had been bringing out features which pointed decidedly in the direction of the Worms.

Among these, one of the most significant is the presence of a pair of symmetrically placed gland-like organs, recently discovered in *Loxosoma*. These organs open on the surface of the body, and vividly suggest the well-known "segmental organs" of worms. It is in the Endoprocta (which now include the four genera, *Pedicellina*, *Umatella*, *Loxosoma*, and the curious *Ascopodaria* discovered by Busk among the collections of the 'Challenger') that the most decided vermal approximation can be demonstrated.

Loxosoma.* — The Rev. A. M. Norman, M.A., writes to point out that what he considered tentacular appendages attached to the caudal extremity of a Gephyrean which he described in 1861 (dredged in Bantry Bay) were obviously Vogt's *Loxosoma phascolosomatum* described in the 'Archives de Zoologie Expérimentale,' vol. v. (1877) and 'Quart. Journ. Micr. Sci.' n.s. vol. xvii. (1877). The mistake into which he had fallen is attributable to the fact that in 1861 *Loxosoma* had never been heard of, nor was any genus known at all like it, added to the fact that the parasite was so firmly attached to the epidermis of the host that it was almost impossible to remove it unmutilated.

Mr. Norman thinks that now attention has been directed to the subject several other species of the semi-parasitic Polyzoa will be found in British waters. They should be especially looked for on the Annelida, also on Hydrozoa, Sponges, &c.

Some valuable remarks of Oscar Schmidt † upon the memoirs on *Loxosoma* are translated in a subsequent number of the 'Annals.' ‡

Barbed Hooklets on Spines of a Brachiopod.§ — Dr. Young, of the Hunterian Museum, Glasgow, writes that Mr. Thomas Davidson describes on p. 275 and figures in plate xxxiv. of the Supplement to his 'Carboniferous Brachiopoda,' now on the eve of publication, some important points in the structure of *Spirifera lineata* Marten which specimens in his collection revealed. In this species the shell structure is minutely punctate, and the flattened spines, which are usually broken off short, contain in their interior a double canal that terminates upon the outer surface of the shell in a series of double pores. Dr. Young recently found a specimen having the spines in

* 'Ann. and Mag. Nat. Hist.,' 5th ser., iii. (1879) p. 133.
† 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 68.
‡ 'Ann. and Mag. Nat. Hist.,' iii. (1879) p. 393.
§ 'Nature,' xx. (1879) p. 242.

place. It appears that these spines are provided with numerous marginal opposite hooklets, usually pointing towards the free end of the spine, a structure which, so far as Dr. Young is aware, is unique amongst the brachiopods, and to which he draws the attention of palæontologists, as perhaps similar structures may be found in other brachiopods.

Arthropoda.

Structure of the Cerebrum and Retina in the Arthropoda.*— Emil Berger finds that the optic ganglion of the *Arthropoda* consists of two parts, one of which is in direct relation to the facetted eye, and goes to aid the layer of rods in making up the retina, while the other part is more directly connected with the cerebrum, and is to be regarded as a proper part of that organ. The *retina* consists of five layers, which, passing inwards, are (1) The layer of rods, separated by a fenestrated membrane from (2) the layer of nerve-bundles; (3) The granular layer, where the nuclei are coarsely granular; (4) The molecular layer, containing a finely granular substance, just as in the *Vertebrata;* and (5) The layer of ganglionic cells, which were ordinarily found to be nucleated. Simplest in *Artemia*, the eye becomes more complicated in the higher *Arthropoda*. The relations of the retina to the cortical layer of the cerebrum are particularly interesting in the bee; it is directly continuous with that of the optic ganglion and the ganglionic portion of the retina, and this arrangement seems to show that the last-mentioned structure is merely a *modified part of the cortical layer*. It is interesting to compare this arrangement with the well-known history of the development of the Vertebrate eye.

The pair of nerves which, in the bee, arise from the subœsophageal ganglion are shown to take their origin from the supra-œsophageal ganglion in great part, as it is but little of them that arises from the cortical region of the lower ganglia; this observation explains the presence of the number of transverse commissures which were stated to exist in this region by Leydig. In the *Insecta* the supra-œsophageal ganglion is invested by a cortex containing ganglion-cells, while in the higher *Crustacea* the ganglion-cells are arranged in a number of peripheral and disconnected layers.

Formation of the Blastoderm and of the Germ-layers in Insects.†— Dr. Bobretzky, in his observations on this subject, draws attention to the views of Weissmann and of Metschnikoff. According to the former, the formation of the blastoderm is preceded by the development of a clear and almost homogeneous substance on the surface of the egg; this "blastema" encloses nearly the whole of the egg, and is readily distinguished from the dark granular yolk. In it there appear nuclei, which are, later on, converted into the cells of the blastoderm; and according to Weismann, these nuclei are freshly developed structures, and not descendants of the germinal vesicle. Metschnikoff, however, believes that they owe their origin to the continual division of the germinal

* 'Arb. Zool. Inst. Univ. Wien,' ii. (1878) p. 221.
† 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 195.

vesicle. Brandt is also of opinion that the blastoderm owes its origin to the germinal vesicle; he says that the protoplasm of the blastoderm corresponds to the germinal vesicle, and the contained nuclei to the germinal spot.

Dr. Bobretzky agrees with the latter in his general results, inasmuch as he finds in two species of *Lepidoptera* which he specially examined, that (1) previous to the formation of the blastoderm, morphological elements having the value of true cells, appear in the yolk; (2) some of these gradually pass to the surface, where they form the blastoderm; while (3) others remain in the yolk, and, later on, bring about the formation of the so-called yolk-spheres, which are likewise to be regarded as true cells. The author was not, however, enabled to observe the connection of these cells with the germinal vesicle; and he is still in opposition to Brandt, and in agreement with the great majority of observers, in regarding this structure as the true nucleus of the ovarian cell. As to the blastema of Weissmann, its existence is denied by Brandt, and was never observed by Bobretzky, unless, as he says, the peripheral vitelline layer represents it; but this takes no share in the formation of the blastoderm.

The author rightly insists on the necessity of extended and comparative investigations before deducing any generalizations; and he points out that, in a spider, elements have been observed by Ludwig very similar to those found by him in the egg of the *Lepidoptera*. As to the cleavage in these latter, he points out that as the protoplasmic elements are not all used up in the formation of the blastoderm, they so far differ from what has been observed in the *Crustacea* and *Arachnida*, where the cleavage is complete; but he explains that he is of opinion that the above-mentioned yolk-spheres do ultimately go to form the endoderm, while he believes that the blastoderm really corresponds to the ectoderm. In connection with other observations lately made, it is of interest to observe that the mesodermal bands begin to be segmented some time before the ectoderm.

Mode of Recognition among Ants.*—The Rev. H. C. McCook has made experiments upon two species of ants ("Pavement" Ant—*Tetramorium cæspitum*, and Pennsylvania Carpenter Ant—*Camponotus Pennsylvanicus*) as to their mode of recognizing each other and distinguishing fellow-formicarians from those of alien nests, with whom they at once fight when they meet.

It occurred to him that this recognition was based upon a certain odour which, *in different degrees of intensity*, is emitted by the respective factions; or, which seems less likely, upon the presence in the individuals of the combatants of *two distinct odours*. This degree of odour, or difference in odour, he supposed might be dependent upon some temporary difference in the physical condition, age, or environment of the antagonists. Supposing that there were any basis of truth in this theory, it further occurred to him that the presence of an artificial and alien perfume of sufficient strength to neutralize the distinctive animal odours or degrees of odour, and environ the combatants

* 'Proc. Acad. Nat. Sci. Phila.,' 1878, p. 15.

with a foreign and common odour, would have the tendency to confuse the ants, and disturb or destroy their power of recognition; in which case he conjectured that the result might be their pacification and reconciliation. He therefore made the following tests.

He introduced into a jar, in which he had placed (with some soil) a number of combatants whom he found engaged in battle ("pavement" ants), a pellet of paper saturated with eau de Cologne, the battle being then again at its height. The effect was instantaneous. The ants showed no signs of pain, displeasure, or intoxication—indeed, some ran freely over the paper, but in a very few seconds the warriors had unclasped mandibles, released their hold of enemies' legs, antennæ, and bodies, and after a momentary confusion, began to burrow galleries in the earth with the utmost harmony. On the part of some there was the appearance of thus escaping from the artificial odour, but there was no renewal of the battle, and the quondam foes lived together for several days in harmony. Thus the perfume proved an eminent pacificator, and so far verified the theory. A second and a third experiment was tried, with the like results.

Attention was next directed to the "carpenter" ants, and a similar series of experiments made, the results of which did not, however, at all agree with the previous ones, the perfume having no effect in preventing the decapitation of alien ants introduced into the nests.

Mr. McCook hopes, when a favourable opportunity again presents, to continue this line of observation. The results are put on record, inconclusive as they appear, not only because they seem to be in themselves interesting and valuable, but in order to stimulate the inquiry among others in the same direction, and to invite suggestions and information which other observers may be able to furnish.

Toilet Habits of Ants.*—The Rev. H. C. McCook also states that the Agricultural Ant (and the remark applies to all other ants with which he was acquainted) is one of the neatest creatures in her personal habits. The whole body is frequently and thoroughly cleansed, a duty which is habitually attended to upon eating and after sleep. In this process the ants assist one another, and it is an exceedingly interesting sight which is presented to the observer when this general "washing up" is in progress.

The operation is conducted as follows. The ant to whom the friendly office is being administered (the cleansed, she may be called) is leaning over upon one side as we begin the observation. The cleanser (as we may name the other party) is in the act of lifting the fore-leg, which is licked, the mouth passing steadily from the tarsus up to the body; next the neck is licked, then the prothorax, then the head. The cleanser now leaves, and the cleansed begins to operate upon herself as hereafter described. This process may be seen throughout the entire group. We take another couple. The cleanser has begun at the face, which is licked thoroughly, even the mandibles being cared for, they being held apart for convenient manipulation. From the face the cleanser passes to the thorax, thence to the haunch, and so

* 'Proc. Acad. Nat. Sci. Phila.,' 1878, p. 119.

along the first leg, the second and third in the same manner, around the abdomen, and thence up the other side of the ant to the head. A third ant approaches and joins in the friendly task, but soon abandons the field to the original cleanser. The attitude of the cleansed all this while is one of intense satisfaction, quite resembling that of a family dog when one is scratching the back of his neck. The insect stretches out her limbs, and as her friend takes them successively into hand, yields them, limp and supple, to her manipulation; she rolls gently over upon her side, even quite over upon her back, and, with all her limbs relaxed, presents a perfect picture of muscular surrender and ease. The pleasure which the creature takes in being thus "combed" and "sponged" is really enjoyable to the observer. He had seen an ant kneel down before another, and thrust forward the head, drooping quite under the face, and lie there motionless, thus expressing as plainly as sign-language could her desire to be cleansed. He understood the gesture, and so did the supplicated ant, for she at once went to work.

The ants engaged in cleansing their own bodies have various modes of operating. The fore-legs are drawn between the mandibles, and, as far as could be ascertained, also through or along the lips, and then are passed alternately back of the head, over and down the fore-head and face by a motion which closely resembles that of a cat when cleansing with her paw the corresponding part of her head. Sometimes but one side of the head is cleansed, in which case the foot used is drawn through the mandibles or across the teeth of one mandible after every two or three strokes upon the face. These strokes are always made downward, following thus the direction of the hairs. The hairs upon the tibia and the tarsus seem to serve the purpose of a brush or comb, and he had thought that the object in drawing the leg through the teeth or between the mandibles is to straighten up the hairs, and thus increase their efficiency for service. Not only the fore pair, but also the other legs, are passed, as above described, through the mouth. The second and third pairs are also and oftener cleansed by the fore-legs, as follows: The ant throws herself over upon her side, draws up the middle and hind legs, which are interlocked at the tarsi, and then, clasping them with one fore-leg, presses the other downward along the other two. The fore-legs alternate in this motion. When the legs of one side are cleansed, the ant reverses her position and repeats the process. When the antennæ are cleansed, they appear to be taken between the curved spur at the extremity of the tibia and the tibia itself, as one would clasp an object between the base of the thumb and the hand, and are drawn toward the lip of the flagellum, evidently with some pressure. He had thought that he could notice this spur also used as a brush or scraper, in the general application of the fore-leg to the body. It seems to have an articulation at its junction with the tibia. Evidently moisture is conveyed from the mouth and rubbed upon the abdomen, as evidenced by the glossy appearance, which showed the presence of moisture upon the surface.

The amount of time devoted to these toilet duties is very great

with imprisoned ants, but is probably not so great in a state of nature. No doubt, with ants, as with men, an artificial condition of society gives an inducement to a larger devotion to personal appearance. Invariably at night, when the gas-lamp is lit and placed near the glass formicaries, the heat and light, both of which appear to be grateful to them, tempt them out, and they begin operations. So also after eating and when awaking from sleep. In short, whenever they are in a particularly comfortable state, they express their satisfaction by making their toilet.

Malformation in an Insect.*—Dr. H. Dewitz describes a larva of *Atta insularis*, in which the last leg on the left side, instead of lying beneath the larval cuticle like the other five, projected through a hole in the cuticle, its last four joints being exposed. The aperture through which extrusion had taken place had been formed by the partial detachment of an ellipsoidal shred, which remained attached along the outer side of the aperture like a valve. Both this valve and the edge of the aperture were strongly chitinized.

Parasitic Insects.†—Dr. Gurlt gives a new list of vertebrates (76 mammals and 519 birds), on which various species of parasitic insects live; the name of each host being followed by those of its parasites.

Notes on Phryganeæ.‡—Fritz Müller, writing from Brazil, makes some remarks upon this group, first stating that he has found (rudimentary) persistent tracheal gills (as in *Pteronarcys*) in one species (? *Tetracentron*), while in another these gills were cast off at the assumption of the imago condition. The same imago had on the anterior edge of the third to the sixth rings of the abdomen peculiar processes, which were absent from the remaining somites; on the end of the fifth ring there were also two dark chitinous plates. All these structures, quite useless to the adult insect, are the persistent remains of tooth-like plates, so strongly developed in corresponding positions in the larva, and assisting it in creeping in and out of its tube. The insect in question, therefore, affords an example of two kinds of rudimentary organs; first, organs inherited from an adult ancestor to whom they were of use; and secondly, organs having reference only to the larval condition, and subsequently transmitted to the adult.

The pupa of a species of *Rhyacophila*, the larva of which lives amongst the branches of *Podostema*, has well-developed claws terminating the first and second legs. These are useful to the insect as it creeps through the tangled branches of the plant.

According to the characters of the pupæ, the *Trichoptera* may be divided into two groups: in one (*Rhyacophilidæ* and *Hydroptilidæ*), the larvæ are quiescent in closed webs; in the other (*Leptoceridæ*, *Sericostomidæ*, *Hydropsychidæ*, *Limnophilidæ*, and *Phryganidæ*), the webs or cases have an opening at each end, through which a stream of water, due to the movements of the pupa, is constantly passing.

* 'Zool. Anzeiger,' ii. (1879) p. 134.
† 'Arch. f. Naturg.,' xliv. (1878) p. 162.
‡ 'Zool. Anzeiger,' ii. (1879) p. 283.

Habits and Intelligence of Vespa maculata.*—This hornet is, according to Mr. Meehan, gifted with great intelligence; on one occasion he observed one with a summer locust several times its own size, endeavouring to rise with it from the ground, but failed from the great weight of the locust. It then walked with its prey about thirty feet to a tall maple, which it ascended to the top, and then flew off with its burden in a horizontal direction. There was more than instinct in this act. There was reasoning on certain facts and judgment accordingly.

Observations on Peripatus.†—Mr. F. M. Balfour, of Cambridge, has lately made some observations on this animal, the discovery of whose tracheal system is, as he justly points out, "one of the most interesting results obtained by the naturalists of the 'Challenger.'"

Describing the segmental organs which, though noticed by Grube and by Saenger, are not mentioned by Mr. Moseley, he states that he has found them in all segments of the body, except the first two or three post-oral; placed at the bases of the feet, each organ, when fully developed, consists of (1) a dilated vesicle opening externally at the base of a foot, (2) a coiled glandular portion, and (3) a short terminal portion, which, as he believes, opens into the body cavity; they are further stated to resemble more nearly those of the leech than those of any other form with which the author is acquainted. The œsophageal commissures are shown to form what must be regarded as subœsophageal ganglia, which give off large nerves to the oral papillæ; on their ventral side the ventral nerve cords are covered by a thick ganglionic layer, and at each pair of feet dilate into a distinct ganglionic swelling; from each of these there is given off a pair of large nerves to the feet, and the swellings of the two nerve cords are connected by a pair of commissures containing ganglion cells. This observation is of great interest and importance, inasmuch as it has been hitherto stated that there were no ganglia in the ventral commissures of *Peripatus;* in other points also, as for instance in the fact that the nervous system lies between the circular and longitudinal muscles of the body, and is not "in proximity with the skin," there are signs of the organization of the nervous system being of a high character.

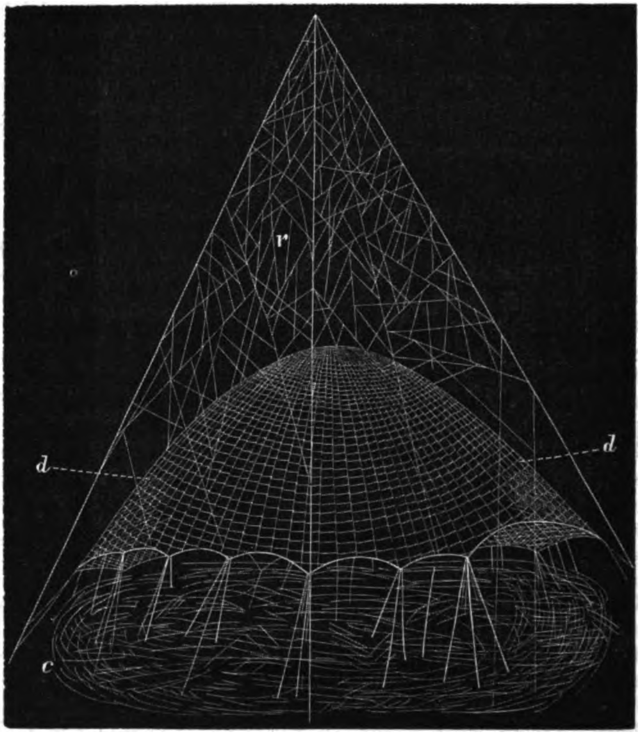
Mr. Balfour also states that he believes that he has evidence of a paired sympathetic system. The organ which, with some doubt, was regarded by Moseley as a fat-body, is now shown to be a glandular tube, which opens into the mouth; not the same as the slime-glands, it "may perhaps be best compared with the simple salivary gland of *Julus*," and if it be homologous with this structure, its presence is of interest as showing that in *Peripatus*, as in the *Tracheata*, there are true salivary glands.

Basilica Spider and her Snare.‡—The Rev. H. C. McCook, in an interesting paper, describes the snare of a spider which he observed

* 'Proc. Acad. Nat. Sci. Phila.,' 1878, p. 15.
† 'Proc. Camb. Phil. Soc.,' III. vi.
‡ 'Proc. Acad. Nat. Sci. Phila.,' 1878, p. 124.

in Texas, and which has been named *Epeira basilica*, "her architecture having suggested the dome-bearing temples of the earlier Christians of the Eastern Church."

The snare was hung about two feet from the ground, upon a bush which stood in the midst of a grove of young live-oaks, and had the composite structure imperfectly represented in the figure. The general



Snare of *Epeira basilica*. *d*, dome; *c*, curtain beneath; *r*, retitelarian snare.

form of the snare was that of a pyramid, the upper part of which, *r*, was a mass of right lines knotted and looped, and crossing in all directions. Within this mass was suspended an open silken dome *d*, constructed of a vast number of radii, crossed at regular intervals by concentrics after the manner of the snare of the common orb-weaving garden spider. The radii were about one-sixteenth of an inch apart at the bottom or circumference of the dome. The concentrics extended entirely and with equal regularity to the summit. They did not cross the radii in circular lines, but presented that notched appearance which is observed in the webs of some orb weavers, particularly those whose snares are horizontal, as, for example, Hentz's *Epeira hortorum*. The meshes formed by the radii and spirals had thus much the shape of the

meshes in a fisherman's net. The diameter of the dome was from seven to eight inches at the base, the height nearly the same. It was suspended in the midst of the mass of right lines by silken guys of like character, which thoroughly steadied the delicate structure, and perfectly preserved its form. Beneath the dome, from two to three inches removed, was a light sheet of cobweb *c*, irregularly meshed, of waving and straight lines. It had a decided convexity upward, and was supported, like the dome above it, and of which it seemed to be a protecting curtain, by silken threads or guys, so stretched as exactly to meet this purpose.

This spider seems to form a perfect link between the orb-weaving and the line-weaving spiders in the characteristic spinning work of the two groups, and the main object of the paper, which is illustrated by nine woodcuts, is to exhibit this fact.

Aeronautic Flight of Spiders.*—In 1877 the Rev. H. C. McCook published† some observations on the ballooning habits of spiders, which he now supplements by several important items, and which he considers make quite complete the mode of ballooning, at least among the citigrade, and perhaps also the saltigrade spiders.

The whole process may be briefly given as follows:—1. The spider seeks a high position, as the top of a fence post, as the point of ascent; 2. The abdomen is elevated to as nearly a right angle with the cephalothorax as may be; 3. A *pencil of threads* is emitted from the spinnerets, the face being meanwhile turned to various points until it looks in the direction of the wind; 4. The legs are stretched upward, thus raising the body aloft; 5. They gradually incline in the direction of the breeze, the joints straighten out, the legs sink forward and down till the first pair are almost on a level with the post, the whole attitude of the animal being that of one resisting some force exerted from above; 6. Suddenly and simultaneously the eight claws are unloosed, and the spider mounts with a sharp bound, apparently, 7, and floats off with the back downward generally, but sometimes with this position reversed; 8. At first the abdomen seems to be in advance, but generally the body is turned so that the head rides in front; 9. The pencil of threads is caught apparently by the feet, and floats out in front, upon which, 10, sometimes the spider will climb upward, as though to adjust the centre of gravity; 11. Meanwhile a thread or pencil of rays issues from the spinnerets, which floats out behind, leaving the spider to ride in the angle of the two pencils, or 12, as it sometimes happens of three which diverge widely at the upper free ends; 13. The feet seem to be united by delicate filaments, which would serve to increase the buoyancy of the balloon; 14. The spider is now carried forward by the wind, riding for long distances in an open space, and often borne high upwards upon ascending currents; 15. Its anchorage appears at times to be in its own volition, by drawing in with the claws the forward pencil, and gathering it in a white roll within the mandibles, but 16, most frequently the balloonist is stopped by striking against some elevated object, or by the subsi-

* 'Proc. Acad. Nat. Sci. Phila.,' 1878, p. 337. † Ibid., 1877, p. 308.

dence of the breeze; 17. A bright warm day in October is commonly chosen for the ascent; and 18. Judging from the presence of a number of dry moults upon many posts, apparently of the same species of spider observed in flight, the animals had recently cast their skins. Of the above points, Nos. 3, 7, 9, 10, 11 in part, 12, 14 in part, 15 in part, and 18 are those which were determined by the last observation.

The object of this interesting habit seems to be the distribution of species.

New and other Pycnogonida.*—Dr. Böhm has a technical paper on the *Pycnogonida* of the Royal Zoological Museum at Berlin, and on the forms found by the corvette 'Gazelle.'

The following new forms are described:—*Nymphon phasmatodes* from the Cape of Good Hope; *N. horridum* from Kerguelen; *Pallene lappa* from the Mozambique, where it was found on *Ophiocoma erinaceus*; *Phoxichilidium digitatum* from Singapore; *Pycnogonum chelatum* (habitat unknown); and the new genus *Corniger* (*Achelidæ*), which is remarkable for having the antennary jaws composed of one segment, whereas in *Achelia* there are two, and in *Zetes* three segments. A beautiful series can now be made out; in the *Nymphonidæ* these organs have three joints and are scissor-shaped, in the *Achelidæ* they are simple, but may consist of one, two, or three joints, and in the *Pycnogonidæ* they are absent. The species of this genus is named *Hilgendorfi*, and was obtained from Enosima, Japan. It is also pointed out that the accessory ova-bearing appendages of *Nymphon* have eleven, and not, as Semper says, nine joints, and that the species obtained from Kerguelen is not the same as the *N. gracilipes* Heller of the Northern seas, and it is therefore called *Helleri*. The characters of the genus *Pallene* are reconsidered, and the new species are figured, with some already known, in two plates. The paper is of value to those who are interested in the study of these curious but difficult Pseudarachnoid forms.

Form of the Muscular Contraction in the Crayfish.†—M. Richet is rightly of opinion that it is of interest to compare the phenomena observed in this crustacean with what has been seen in the frog; he shows that all the caudal muscles have a short period of contraction; that of the pincers is much longer than that of any muscle in the frog, save only the cardiac; it lasts nearly ten times as long as that of the tail-muscle; the "time lost" when the muscle is excited through the agency of the ganglionic chain is very great, amounting as it does to 2·5 hundredths of a second; the tail-muscles soon lose their contractility after repeated shocks, and it is pointed out that this is quite in accordance with the habits of the animal, which never swims for a long period at one time; the muscles of the pincer behave very differently, and this too is what we should expect from the holding power of the animal; finally, this organ, under appropriate conditions, retains its power of contractility four days after separation from the body.

* 'MB. K. Akad. wiss. Berlin,' 1879, p. 170.
† 'Comptes Rendus,' lxxxviii. (1879) p. 868.

Amphion and Polycheles (Willemoesia).*—J. E. V. Boas, of Copenhagen, gives an account of the relations between these two genera, and is of opinion that "probably—or at least, not improbably"—*Amphion* is the larva of *Polycheles*. The structure of *Amphion* shows its affinity to the *Phyllosomidæ*, and proves it not to be a shrimp-larva; and by comparing it with other forms, the author comes to the conclusion on anatomical grounds that it must be referred to the macrurous genus *Polycheles*, one of the *Astacidæ*.

The paper opens with an announcement of the classification of *Decapoda* adopted in the author's forthcoming work on that group. He proposes to take the bold step of separating the *Carididæ* (Garneelen) from the *Macrura*, and making of them a primary subdivision of decapods which he calls *Natantia*: the remaining *Macrura* being united with the *Brachyura* and *Anomura* as a second subdivision, the *Reptantia*.

Life-history of the Bopyridæ.†—Dr. Fraisse gives an account of the life-history of *Entoniscus Cavolinii* n. sp., and of the *Bopyridæ* in general, in which there are ordinarily two larval stages, *Entoniscus* being the sole exception, and that, perhaps, because the second phase has not yet been observed; in the second stage he finds that (1) the form of the body is cylindrical, and somewhat flattened on the ventral surface; (2) the outer antennæ are composed of a large number of joints, and are much longer than the inner ones, which have three joints and are provided with olfactory filaments; (3) the eyes are completely developed; (4) the heart, situated posteriorly, may be easily observed to be beating; (5) the movements of the animal are very lively. *Cryptoniscus* differs from *Bopyrus*, *Gyge*, &c., in having at this stage the sexes separate, a very penetrating smell, and a flask-shaped diverticulum to the rectum; while the seven thoracic segments are not equally developed, and in *Cryptoniscus curvatus* the last two are atrophied.

The paper, which ends by a bibliographical list of more than fifty papers or books on the subject of the *Bopyridæ*, contains an interesting list of the hosts of *Cryptoniscus*; of the twelve species of which it deals, five are parasitic on the *Cirripedia* (one on the *Pedunculata*; four on the *Operculata*), and seven on the *Rhizocephala* (four on *Peltogaster*, and three on *Sacculina*). The author's observations, which are illustrated by twenty-seven figures in two plates, were based on specimens obtained chiefly at Naples.

Vermes.

Development of the Annelides.‡—Dr. Hatschek describes in some detail the development of *Criodrilus* and *Polygordius*; these observations lead to some interesting observations and speculations on the morphology of the *Bilateria*.

Criodrilus.—The eggs of this form were found in cocoons of a size (5 cm. long) much beyond that of most *Oligochæta*, on the banks

* 'Zool. Anzeiger,' ii. (1879) p. 256.
† 'Arb. Zool.-Zoot. Inst. Würzburg,' iv. (1878) p. 382.
‡ 'Arb. Zool. Inst. Univ. Wien,' iii. (1878) p. 1 (277).

of the Danube; the earlier stages appeared to be very similar to those of *Lumbricus;* the mesoderm is first represented by two large cells, which persist for a long time, and the ectoderm by three large cells, which occupy the anterior end, the dorsal surface, and the sides of the embryo; the two mesodermal cells grow out into a row of cells on either side, for which the term of "mesodermal stripes" is now proposed; the old term "germ-stripe" has been used for so many different sets of organs that a more accurate terminology seems indeed to be justifiable, and for it the name "embryonic stripe" (or streak) is now proposed. In the process of histological differentiation the cells of the ectoderm become more clear, but the three large cells, already spoken of, remained filled with dark, coarse granules; albumen is rapidly ingested, and as a consequence the cells of the ectoderm and of the mesodermal stripes increase greatly in number; of the latter two rows appear shortly after the development of the œsophagus, and the two primitive cells become more separated from one another. It is in the same layer that segmentation is first seen, and in it only; this process begins in the most anterior region, and is soon followed by the development of the different organs; still the two primitive cells go on dividing, and so adding to the mesodermal stripes. Contemporaneously with this the cephalic region, which is characterized by the presence of a ciliated groove, which persists till development is all but complete, develops a cavity, which is at once distinguished from the cœlom or body-cavity by its origin from the separation of the ectoderm and endoderm, and not by the cleavage of the mesoderm; it is also single, and not double; the mouth, with its gullet, and the supra-œsophageal ganglia become developed, and this nervous region gradually separates from the ectoderm, although it for a long time remains connected with it in its most anterior portion.

The primitive segments are formed by the separation of parts of the mesodermal stripes, which form small multicellular and quadrangular plates; a single layer of cells from them forms the enteric fibrous layer, the most anterior and the most posterior layer form the dissepiments of the now developing cœlom, and the outer portion becomes converted into the rudiments of the segmental organs and of the setæ; the former set of organs commences with one large cell in each segment, which is connected with a row of smaller cells, which extend into the next segment; these all become differentiated into three parts, the two terminal straight, and the middle one looped; while the whole apparatus leaves the ectoderm to take a deeper position in the body. These segmental organs are found in all but the first trunk-segment, but even in this Dr. Hatschek has observed a collection of cells which disappear later on, but which would seem to be similar in character. The more final stages of this form are not described, as they differ in no important points from what is already known to be the course of development in *Lumbricus.*

Polygordius.—With regard to this somewhat enigmatic creature, it is interesting to be reminded of Schneider's discovery of the fact that the so-called "Lovenian larva," first described by Professor Loven in 1842, and since examined by Professor Alexander Agassiz, is without

doubt the larva of *Polygordius*; of the six stages into which the author divides the history of this form the first, or that prior to segmentation, is the most interesting. Small and transparent, the larva is more broad than long, and is divided into two parts by two parallel circlets of cilia in the middle line; the mouth is placed between these and the anus, which is found at the inferior pole of the body; superiorly there are two eye-spots; the cuticle is, for the most part thin, and in the region of the trunk forms a layer of cubical cells; the region of the anterior circlet is invested by a thick cuticle, which is traversed by pore-canals for the long cilia, which seem to be nourished from a mass of cells set anteriorly, and containing fatty and albuminous granules: the cuticle of the cells of the posterior circlet is but slightly thickened, but the same pore-canals are again to be observed The pigment spots are dark brown, and the region with which they are connected will form in time the supra-œsophageal ganglia; connected with this, on each side, are three nerves, one of which is much larger than the others, and all of which go to form the peripheral nervous system. As in *Criodrilus*, the primitive segments are first developed in the mesodermal stripes, and as, not only in it, but in *Unio* among Lamellibranchs, and in *Pedicellina* among the Bryozoa, there are, for a long time, two distinct primitive mesodermal cells at the posterior end of these stripes. A number of muscular fibres are early developed in the head, as is also a delicate ciliated canal on either side, which forms the head-kidney, and gives rise in the future to the "segmental organs" of the trunk. This canal communicates with the body-cavity by the funnel-shaped orifice so characteristic of this organ.

As to the enteric canal, we have to observe that, as so often happens, it is the mid-gut only that is developed from the endoderm; there is a diaphragmatic elevation in the lumen of the fore-gut which is provided on the side most remote from the mouth with long cilia, which appear to be able to act as a kind of sieve; the hind-gut has muscular fibres connected with its walls, which are apparently of assistance in the special function of this part.

The succeeding stages are characterized (2) by the appearance of the primitive segments of the trunk, the further development of the mesoderm, and of the posterior circlet of cilia; (3) the greater elongation of the larva and the differentiation of the ventral cord and antennæ, as well as of a ciliated pit on either side of the head, which seems to represent the future olfactory organ. (4) In this stage the walls of the enteric canal become strengthened by the apposition of the proper division of the mesoderm, and the posterior circlet of cilia becomes greatly developed. (5) The cuticle of the trunk becomes thicker, and the region of the head becomes much more like what it will be in the adult, while its circlets of cilia begin to disappear. (6) Two distinct regions are apparent in the head, the tentacles project on either side, the walls of the mid-gut are considerably thickened, and there is still a mass of rounded indifferent cells, which appear to be the rudiments of the generative products.

As to the systematic position of *Polygordius*, Dr. Hatschek agrees with Uljanin in regarding it as belonging to the Annelides, although

it exhibits many points in adult structure, which are merely embryonic in other forms; thus segmentation never affects any other than the mesodermal structures, the central nervous system is never placed otherwise than just below the ectoderm, the supra-œsophageal ganglion retains its early (anterior) position, and the ventral cord does not develop ganglionic enlargements. Connecting this form with the higher Chætopoda is the interesting *Saccocirrus*, which may be taken as the type of the Archi-chætopodes, just as *Polygordius* may represent the Archi-annelides; regarding the Hirudinea and Gephyrea as belonging to the same series, we get an arrangement of this kind:—

Annelides.
1st order. *Polygordiidæ.*
2nd order. *Chætopoda.*
1st suborder. *Saccocirridæ.*
2nd „ *Polychæta.*
4th order. *Gephyrea.* 3rd „ *Oligochæta.*
3rd order. *Hirudinea.*

The head of the annelid is regarded, in opposition to Professor Semper, as consisting of a single segment, which is characterized by the possession of an œsophagus and of a supra-œsophageal ganglion, and in having a cavity derived from the primitive cœlom, while there are never, as there are ideally in all the rest, generative organs. Whether the annelid is a colony of segments with an anterior sterile individual (the head), or whether it consists of a head and trunk, which latter undergoes a process of gemmation, must still remain a moot question; but it is not, in any case, to be compared with the Cestoid Worms, which differ altogether in having the *youngest segments nearest the head.*

The name *trochophore* is proposed for the larva of *Polygordius*. This is, from any point of view, a very instructive form. Found adult in the Rotatoria, it is continually met with in the developmental history both of the Annelides and of the Mollusca; its oral circlet of cilia consists of a double-rowed pre-oral portion, a single-rowed post-oral circlet, and a ciliated groove separating the two. The frontal nervous plate, which is the rudiment of the supra-œsophageal ganglion, appears very early; it has been recognized in the Rotatoria and the Mollusca, and the primary tentacles which become connected with it appear to be homologous with the "tentacles" of the last-named group. Difficulties presented by the characters of the so-called segmental organs are dealt with in a very ingenious manner; while as to the generative organs, it is nsggested that in the Rotatoria they have disappeared on one side. Having in mind all these similarities, Dr. Hatschek proceeds to suggest the existence of a common ancestor for the Rotatoria, Annelides, and Mollusca, for which he proposes the name of *Trochozoon.*

The *Bilateria* are those animals in which there are three distinct layers, and in which the genital products are derived from the mesoderm. To deal with the different groups:—

Echinodermata.—The larvæ of these forms have no excretory organs and no frontal plate, while the vaso-peritoneal organs are formed from the endoderm, and the adult is of a radiate form. As these animals

were undoubtedly fixed in the earlier periods of their time-history, this radiate character is, in them, just as in certain fixed Annelids or the fixed Tunicate (*Octacnemus*) described by Mr. Moseley, probably due to their mode of life. The views of Haeckel as to the colonial character of these forms, and of Alex. Agassiz with regard to their affinities to the Ctenophora, are rejected: the Gasterotricha and the Nematodes (*Vermes archicœlomati*), the Platodes (by degeneration *V. acœlomati*) as well as the Nemertini and the Bryozoa are regarded as close allies of *Trochozoon;* while as to the Brachiopoda, which are regarded as Molluscoidea, and as to the Mollusca proper there appears to be sufficient evidence of their rightful position in a similar category; the Nemertinea are, in the adult stages, difficult forms, but the *Pilidium* larva is sufficiently indicative of their phylogeny.

The adult Annelides are characterized by the development of the dermo-muscular tube, the formation of the secondary cœlom in the trunk, and the appearance of the ventral ganglionic cord, after the development of the supra-œsophageal ganglia; with these the Arthropoda are regarded as undoubtedly connected, while the absence of any Trochozoon-like larva is explained by the characters of the *Nauplius*, in which the presence of chitin in the cuticle and of the characteristic locomotor appendages are sufficient reasons for the absence of cilia.

Dr. Hatschek has no doubt as to the correctness of the views of Anton Dohrn as to the degraded character of the Tunicata of the present day, and as to their direct relations to the Vertebrata on the one hand, and the unsegmented Worms on the other. As to the Annelides and Vertebrata there are ample indications of their affinity; neither the dorsal region nor the mouth are homologous, but in the rudiments of their nervous apparatus, of their circulatory system, of their renal organs, and of the disposition of the muscular tracts there is ample evidence; the sensory organs are arranged on the same plan, and the only point of difference in their renal organs is the retention by the Vertebrata of the unsegmented excretory canal. The two groups are regarded, finally, as having had a common ancestor, less differentiated than *Polygordius*, from which the Vertebrata have most strikingly diverged by the development of a *chorda dorsalis* of endodermal origin, and by the formation of a new mouth and of branchial clefts, coupled with the loss of the primary œsophagus.

Anatomy of Magelona.*—Dr. W. C. McIntosh's paper on this subject (published in abstract by the Royal Society) finds a home in a German journal.

The animal in question, long since known to Johnston, but only described by name (*Mæa mirabilis*) in the British Museum Catalogue of Worms (1865), was made known to science by Fritz Müller in 1858. Found in large quantities at St. Andrews, it has also been found at Southport; from 150–200 mm. long, it is of a pale rose colour anteriorly, and of dark greyish-green posteriorly; the cephalic lobes are eyeless, considerably flattened, and diminish towards the

* 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 401.

margin. On either side of the head there is a long tentacle, provided on its anterior surface with cylindrical papillæ. The segments of the body are numerous, and gradually decrease in size as they proceed backwards; terminally there is a broad papilla with a style-shaped appendage on either side and bounding the anus. The body may be divided into two distinct regions; the anterior one is provided with nine double pairs of bundles of setæ, and in this point presents some resemblance to *Heterospio longissima*, described by Ehlers. The setæ of the ninth segment are remarkable for the characters of their tips, and seem to be homologous to those that are found on the third segment of *Disoma*, the fourth of the Chætopteridæ, and the fifth of *Polydora*; the segments behind the ninth are severally provided with two rows of setæ on either side; as to their position on the segments, it is to be noted that those in the anterior portion are found towards the most anterior edge of each segment; but those of the ninth have a more extensive origin; and behind it the setæ gradually pass from the anterior towards the posterior edge of each segment.

As to the integument, we have to note its high degree of development in the cephalic and anterior regions, which appears to be correlated with the large amount of friction to which the animal is subjected in moving through the sand; and in connection with this observation it is interesting to observe that Claparède had noted the delicacy of the integument in sessile annelids. The hypodermis is exceedingly well developed. The lateral lamellæ consist typically of a delicate cuticular layer investing the hypodermis; at their base there is a bundle of simple setæ, but no vessel has been observed to pass to them. In the anterior region the dorsal lamellæ are larger and more transparent than the ventral.

In structure the hypodermis is very similar to the integument of the Nemertinea; it consists of a number of flask-shaped cells or glands, the contents of which have the form of clear and of granular spheres; in the region of the cephalic lobes especially it is possible to observe a number of rod-cells, which form a transverse band across the body, behind each row of hook-like setæ; these are also well developed in the caudal region. In the tentacles there are a number of small, but distinctly granulated hypodermal cells.

The muscular system of the cephalic end of the worm consists of a median and of a lateral pair of longitudinal muscles; the lateral muscles are connected by a chitinous portion, which gives off a thin lamella on either side; the function of this portion is evidently connected with the habitat of the animal; it replaces a circular muscle, and supports the vessels; while the completeness of the arrangement is spoken to by its connection with the base of the tentacles. In the space on either side of the mouth there is a series of vertical muscular fibres, which have a dorsal origin, and are inserted into the superior margin of the mucous membrane of the mouth, for which tissue they appear to serve as retractors. The muscles to the setæ are, as a rule, feebly developed, but are very similar to those of allied forms. It is impossible for us to follow the author through all his details, but it may be of interest to point out

that the muscular system of this animal is evidently capable of enabling it to pass through the damp sand with great rapidity, as well as to circle through the water with great ease.

The mouth is triangular or T-shaped in form; the upper lip is not, as is the lower one, cleft; both are in life capable of great power of movement; the intestinal tract appears to be somewhat complicated, as is also its appendage, the proboscis; with regard to which it is pointed out that its structure is such as to enable it to bore unceasingly into the sand, and so to make a passage for the more delicate hinder parts of the body; it is of a pale reddish colour. The anterior region of the enteric canal is well provided with muscles, and is very firm, thanks especially to the chitinous investment of its glandular layer; it has a close homology to the œsophageal region of the Nemertinea, which it strikingly resembles in the possession of a *rete mirabile;* the cilia of the other form are here replaced by chitin; a further point of resemblance is to be found in its retention of irritability long after death. *Magelona* is shown to subsist on the cast chitin of Crustacea, on Foraminifera, and so on, while the ingestion of sand appears to be a necessity of its existence. The blood is richly supplied with blood-corpuscles of a pale red colour; in 1852, Dr. T. Williams stated that there was no species of annelid in which the true blood contained morphotic elements; but this statement, which is now shown not to hold for *Magelona*, and has been lately shown to be untrue of the earthworm, is also untrue of *Terebella* (R. Wagner), *Glycera*, *Phoronis*, and *Syllidia armata* (Quatrefages), and of some *Staurocephalida*, *Cirratulida*, and *Opheliida* (Claparède).*

The cœlom is very indistinct in the anterior region, and in it no perivisceral corpuscles were to be observed; behind the ninth segment it widens out, and has, in section, a circular form; it is divided by a median ligament, and its contained clear fluid is provided with corpuscles, which are not very numerous, and vary a good deal in form. The central nervous system is situated in the hypodermis, and the nerve-trunks run in a very distinct neural canal. The tentacles are completely devoid of cilia, but the vas efferens has a remarkable contractility, so that it takes the place of the cilia in respiration. Having made some remarks on the generative organs, the author concludes that *Magelona* has several points of affinity to *Prionospio* and *Heterospio*, and others to *Spiochætopterus;* the structural arrangements of the proboscis, cephalic lobes, and circulatory organs are *sui generis*.

Arrangement of the Nerve Cords in the Annelides.†—The arrangement of the nerve cords varies so greatly in the Annelides, and a knowledge of the subject is so important from many points of view, that it seems well to give a separate note on this subject, the basis for which is to be found in Dr. McIntosh's paper on *Magelona*.

(1) In some, the trunks lie internally to the muscles, or in a ventral cleft between them; the transverse band between the ventral muscles and the hypodermis lies externally to them; among others

* The account of the circulatory system reappears in the 'Journ. Anat. and Phys.' (Humphry) for April, 1879.

† *Loc. cit.*

this arrangement is found in the Euphrosynida, Amphinomida, Aphroditida, Polynoida, Phyllodocida, Syllida, Nereida, Eunicida, Chlorhæminida, and Amphictenida.

(2) The nerve trunks are placed externally to the muscular layer and in the hypodermis; the oblique muscles taking their origin from a transverse band set superiorly or laterally to them, as in the Sigalionida, Hesionida, Ariciida, Chætopterida, Spionida, Cirratulida, Ampharetida and Terebellida.

(3) The trunks are embraced by the closely approximated ventral or other longitudinal muscles; as in the Glycerida and Telethusida.

(4) In the substance of the ventral longitudinal muscles, as in the Hermellida.

(5) Beneath the ventral long muscle, or at its margins, or internally to the circular layer, as in some Sabellida and Serpulida.

In some families there are neural canals, which are largest in the Spionida, and are best seen in *Magelona*.

Gills of Serpula.*—Dr. L. Löwe, of Berlin, deals with the structure of these organs, and enters into the question of the relations of the Annelides to the Vertebrata; his observations are based on the form known as *Spirorbis*, which differs from *Spirographis*, already examined by Kölliker and Claparède, in the absence of the cartilaginous gill-skeleton.

About thirty branchial filaments spring from a branchial lobe on either side of the mouth; each of these has the form of an elongated cone, in which it is possible to distinguish a shaft and a vane; the former, which decreases in size towards its apex, consists of (1) an external cuticle, (2) a closely applied cellular layer, (3) a vascular layer, and (4) a cuticle; the vane is made up of a central part, which is the continuation of a vascular layer, and of a marginal portion, which consists of a cuticle and a chitinogenous epithelium; all these structures are described from a histological standpoint, and the changes which the gill undergoes during growth pointed out; the concluding portion of the paper is occupied by an extremely ingenious comparison of the gill-apparatus of these forms with the branchial clefts of the Vertebrata.

Two observers, working independently, have lately shown that the Eustachian tube and the tympanic cavity are primarily formed by a diverticulum of the oral cavity, while the external auditory meatus is formed by such part of the first gill-cleft as is not obliterated; Dr. Löwe has confirmed the essential points of these observations, and gives a figure of an embryo of the sheep in support of them; this displays the following points; from the oral cavity there is given off outwards and backwards a long narrow cleft, which is the rudiment of the Eustachian tube; this at its outer end widens out and forms the tympanic cavity; there comes to meet this an invagination of the epidermis which forms the external meatus, while between these two processes there is a region in which appear the auditory ossicles and the tympanic membrane. Turning now to

* 'Zeitschr. wiss. Zool.,' xxxii. (1878) p. 158.

Spirorbis, we see that of the depressions derived from the lumen of the enteric tube the one which is placed most dorsally is the longest and deepest, or, in other words, has just the same relations to the other depressions as has that one in the sheep which goes to form the Eustachian tube; of the clefts between the branchial filaments the longest one is found between the first and second, and it appears to have just the same relations as the branchial cleft in the mammal. We have not space to follow out the descriptions of the relations of the nasal organ and of the other clefts in *Spirorbis*, or that of the palatal portions of the upper jaw and the connecting pieces of connective tissue found in the oral region of the worm, but we would observe that with regard to that most vexed of questions—the relations of the nervous system of Annelids and Vertebrates—the observations of Dr. Löwe point to the absence in the Annelid of anything homologous to the dorsal medulla of the Vertebrata; these views, though now held by various morphologists, do not, as is pointed out, agree with the speculations of Kowalewsky, who looks upon the whole of the supra-chordal nervous system of the Vertebrata as homologous with the whole nervous system of the Annelides; or of Semper, who identifies the ventral medulla of the latter as the dorsal medulla and brain of Vertebrates; or of Dohrn, who looks upon the whole brain of the Vertebrata as homologous with the cephalic ganglion of the Annelides.

New Annelids from the Philippines.*—Professor Grube has communicated to the Academy of Sciences at St. Petersburg a memoir on the forms collected by Semper in his voyage; four new genera and 142 new species are described by the learned zoologist, who points out that the Alciopidæ, Nephthydæ, Ariciadæ, and Cirratulida are altogether unrepresented in the collection, and that the genera to which the new species are assigned have, in many cases, been hitherto represented by one or two species only. The value of this paper, which extends to 300 pages (illustrated by 15 plates) is enhanced by the diagnoses of the families under which they are grouped, so that so far this essay may be regarded as a revision of some families of the Annelides.

Trichinosis in a young Hippopotamus.†—M. E. Heckel describes some observations made by him upon a young hippopotamus, about two years old, which died on the 10th of May last in the Zoological Garden of Marseilles, having been received from Egypt about four months before. The animal was in bad health all the time of its residence at Marseilles, and its skin showed an eruption of confluent boils. When removed, the skin showed several lesions in the shape of deep ulcerations, which, having originated around a hair, had attacked the bulb, and thus formed a canal leading generally into a great purulent cavity. Smaller ulcerations led into smaller cavities, bounded by a proper membrane like true cysts, and filled with creamy pus. The examination of a section of the muscular tissue surrounding

* 'Mém. Acad. Imp. Sci. St. Petersbourg,' xxv. (1878).

† 'Comptes Rendus,' lxxxviii. (1879) p. 1139; 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 99.

one of these cysts, showed it to contain great numbers of *Trichina* cysts resembling those of *Trichina spiralis*, with which also the enclosed worm agreed. The cyst, however, seemed to be much more developed than in the pig or in man.

Upon this curious and interesting fact the author makes the following remarks:—"I am ignorant what relations may exist between the presence in the same animal of *Trichina* and of enormous cysts filled with pus; but the fact indicated by me appears to possess some interest . . . . because it seems to prove that the Pachyderms, more than other animals, are exposed to the spontaneous developement of this terrible parasite—an important point which may serve to throw some light upon its hitherto unknown migrations. It has been attempted to explain the frequency of the *Trichina* in the pig by the consideration of the voracity and filthy habits of that animal. The fact to which I now call attention seems to protest against this opinion, for the hippopotamus by no means shares in the mode of existence and the tastes of the pig, and we can hardly suppose that captivity, by the special diet which accompanies it, could have a marked influence upon the development of the Nematoid worm.

New Diseases of Hot-house Rubiaceæ.*—M. Max Cornu says, that a disease, hitherto unknown, devastated the hot-houses in France last February, attacking the roots and forming swellings on the small and even on the large roots.

Transverse sections of these swellings showed, under the Microscope, amidst the hypertrophied portions, cysts enclosing the eggs of *Anguillulæ* in great number; the Rubiaceæ (*Ixora* and *Hamiltonia*) attacked, lost most of their leaves, the rest being dried up. This malady presents great analogy with that described by M. Jobert,† which ravages the coffee plantations, a species of the same family in Brazil.

Adult individuals are very rare; and the eggs exist singly, and should be destroyed in this form.

These eggs are enclosed in cysts with rather thick walls opening on the outside. When hatched the *Anguillulæ* immediately issue and make their way towards the new roots; once established in the tissues they are safe.

It is worthy of remark that the encystment, the date of which seems coincident in the two species, is in France hibernal; in Brazil it would correspond with the dry season, and be æstival; the plants preserving in the hot-houses the seasons of their country.

Female Organs of Echinorhynchus.‡—Dr. Angelo Andres describes these structures in *E. gigas*, his short and very condensed paper being illustrated by a folding plate of remarkably clear figures. The complication of the organs renders it quite useless to attempt a description of these without drawings, especially as the real nature of many of the parts is by no means thoroughly understood.

* 'Comptes Rendus,' lxxxviii. (1879) p. 668.
† This Journal, ii. (1879) p. 168.
‡ 'Morph. Jahrb.,' iv. (1879) p. 584.

Jensen's Turbellarian Worms of Norway.—Marine zoologists will be interested in the appearance of this valuable work on the marine flat-worms of the Norwegian coast. A number of new forms are described in considerable detail, with excellent figures, while the descriptive portion is preceded by full anatomical details. The work is done in the careful, conscientious manner characteristic of Scandinavian zoologists. The descriptions are both in Latin and Norwegian, so that the work is accessible to students in general.

Reproductive Organs of the Marine Ectoparasitic Trematoda.*—It is impossible in an abstract to do full justice to M. Carl Vogt's careful descriptions of the generative apparatus of several of these forms, which he has lately been examining at Roscoff. A point of especial interest is the discovery of the characters of the orifice of the common reservoir or ootyp (Van Beneden). This opening has a well-marked contour, and is surrounded by short fibres, arranged radially, at the edge of which there were obscure indications of ciliary movements; but what was more remarkable was that, from time to time, the orifice effected movements which could only be compared to those of swallowing, and it is proposed therefore to call it the "swallowing orifice" (Schlucköffnung); its function is evidently to aid the germs in their passage through their duct. The writer says that he cannot describe his extreme astonishment when he first saw this orifice in action in Dactycotyle, where the yolk-spheres and ova were thrown about, just as a juggler plays with his balls.

As to the female organs in general, it may be observed that the germ-gland is in all cases simple; it may be spherical as in *Udonella* and others, or it may be elongated; the branched vitelline ducts do not vary much in character, and generally open directly into the ootyp; this latter organ is formed at the point where the ovarian germ, the masses of yolk, and the semen meet; in some it is saccular, and in others canalicular. The oviduct varies in length, and the uterus in capacity, in some cases being so small as to be only able to contain a single egg. The most important differences are to be found in the copulatory organs. In *Polystomum* and *Calicotyle* the parts are most highly differentiated, and there are two female copulatory orifices in addition to the opening into the uterus by which the mature ova are evacuated; in *Microcotyle*, *Udonella*, and others, this uterine orifice appears to serve also as the copulatory orifice; in *Diplectanum* there is a special copulatery duct, which is completely separated from the uterus and its orifice, and has a common aperture with the penial pouch.

The male organs exhibit greater variety. *Udonella* has a single rounded testis; in *Phyllonella* and *Epibdella* two testes lie on either side of the median line, while in *Dactycotyle* and *Diplectanum* and others there are a number of testicular tubes scattered in the parenchyma or collected together about the median line. As to the efferent ducts, they have, in *Phyllonella*, *Epibdella*, *Udonella*, and *Calicotyle*, no other connection with the female organs than what is afforded by the possession of a common orifice. In *Dactycotyle* a canal passes from

* 'Zeitschr. wiss. Zool.,' xxx. Suppl. (1878) p. 306.

the seminal duct into the ootyp, and this has been observed by Vogt as filled with semen; in *Polystomum* Zeller has reported the presence of a duct connecting one of the testicular tubes with the ootyp; in *Microcotyle* the testicular bodies open directly into the ootyp. As to the appended structures, penis, penial glands, and so on, the variety is extreme. Great difficulties surround the explanation of the arrangements that obtain in *Diplectanum*, which M. Vogt hopes to be able to resolve on another visit to Roscoff.

This paper is reviewed in part iii. of M. Lacaze-Duthiers' 'Archives' for 1877, which was only published early *this* year.

Organization of Axine and Microcotyle.*—The specimens for Herr Lorenz's examination of these interesting Trematodes were chiefly obtained at the Zoological Station at Trieste.

Axine belones is a parasite of the fish *Belone esox*, on the gills of which it lives; first described by Abilgaard in 1794, it has since been observed by various zoologists, among whom are Van Beneden and Hesse, and in the opinion of Herr Lorenz the form described by them, *A. orphii*, is identical with Abilgaard's species. From four to eight mm. long, with an acute anterior, and a broad hinder end, it is of a milk-white colour, and almost transparent; but it is chiefly remarkable for its asymmetry; the right side is the longer and is convex, while the left is faintly concave; four groups of hooks or chitinous rods surround the anus; in the centre there are eight to twelve hooks, and on either side there are from twelve to twenty hook-shaped rods, while at the base of the cirrus there are from sixteen to twenty-four. The external integument is formed by a delicate cuticle, between which there is a thin layer of finely granular protoplasmic substance. Of muscular fibres there are two kinds; one longitudinal, and ending in fine filaments, and the other formed by a tissue of much more delicate fibrillæ, which run in three distinct bands. The seizing organs, which are not suckers, though they have their function, occupy the whole of the hinder edge of the body: the nerve-centre is apparently represented by a curved band, which lies in the parenchyma of the body above the œsophagus, and consists of yellowish-coloured fibrous and finely granular substance; the fine fibres given off from it are very soon lost in the parenchyma of the body. Anteriorly to the mouth there is a funnel-shaped cavity, with a right and left sucker; these latter are formed of a thick muscular integument, which is traversed by a number of closely set radial muscular fibres. The œsophagus forms a simple tube as far as the common generative orifice, where it divides into the two arms of the enteron, which soon take on a dendritic appearance, owing to the presence of short cæca. The two arms do not unite at their distal end; the enteron does not seem to have any special wall, but to be merely a cavity in the parenchyma of the body; it is, however, provided with a number of pigment cells, which are filled with small dark-brown granules. The *excretory vascular system* of *Axine* is very well developed, and has the form of two internally ciliated longitu-

* 'Arbeit. Zool. Inst. Univ. Wien.,' iii. (1878) art. ii.

dinal canals, which run parallel to and above the arms of the enteron; the primary trunks give off a large number of small canals, which extend into the parenchyma and seem to traverse every space in it. There are two large testes, a seminal duct with a vesicle, and a well-developed cirrus (penis); the female organs are composed of an ovary, an efferent duct, receptaculum seminis, vagina, uterus, paired yolk-glands and their ducts. This form seems to be distinguished from all other *Polystomeæ* by possessing three ducts carrying the deuto-plasm into the oviduct; the ovum seems to be matured as in other *Trematoda*, but only one comes to development at a time.

The genus *Microcotyle* was established by Van Beneden and Hesse, but its points of difference from *Axine* have never yet been very clearly put out; its most striking variation is now shown to lie in the fact that, unlike *Axine*, it is completely symmetrical; it is also distinguished by the absence of the penis, and the position of the vaginal orifice in the median dorsal line of the body (in *Axine* this orifice is marginal in position); while, again, *Microcotyle* does not present merely one mature egg in its oviduct, but a number, which may come to be as high as twenty-four.

The new species, *M. mormyri*, is described by Herr Lorenz: Van Beneden and Hesse had described four species, *M. labracis* from *Labrax lupus*, *M. Donavani* from *L. Donavani*, *M. erythrini* from *Pagellus erythrinus*, and *M. canthari* from *Cantharus griseus*; as to the first two the author is certain that his species from *Pagellus mormyrus* is quite distinct; as to the third species, the difficulties as to their proper identity are removed not only by the difference in the arrangement of the bands on the body, but by the more important character of the bundles of chitinous rods, which are found around the genital orifice; in *M. erythrini* they are arranged in two small groups set one in front of the other, but in *M. mormyri* there are two sets; 8 to 12 are arranged radially and in a curved manner, and behind and on either side there are 25 to 30, which have their hooks directed forwards; the points of difference to *M. labracis* are brought out in the full description of the new form; in many points of its internal structure it is shown to agree with *Axine*; but the vagina forms a large vesicle, placed in the middle of the body and provided with a wide orifice; its superior portion and margin have an almost chitinous character, but the lower part has its wall thin, and is continued into a canal which is formed by the union of the branches of the paired vitelline duct. The coverings of the egg are proportionately very large; they are of an elongated oval form, and pass into a gradually diminishing appendage, which is coiled at its tip; in which character it also differs from *M. canthari*, as described by the Belgian zoologist.

Life-history of the Tape-worm of the Shrew.* —M. Villot announces the discovery of the cystic forms of two of the four species of *Tænia* which infest the European Shrews, and which have hitherto only been known in the sexual stage.

The two species of bladder worm are placed by Villot in a new

* 'Ann. Sci. Nat. (Zool.),' viii. (1879) No. 2–3.

genus *Staphylocystis:* one species, *S. micracanthus*, is undoubtedly the immature form of *Tænia pistillum*, parasitic on *Sorex* (*Crocidura*) *araneus:* the tape-worm with which *S. bilarius* is connected is uncertain, but it is certainly nearly allied to *T. scutigera* (of *Sorex tetragonurus*), and to *T. scalaris* (of *S. araneus*).

Both species are found in the little myriapod *Glomeris limbatus*, where they occur in clusters like grape-bunches on the outer surface of the Malpighian tubules. Each cluster is a colony of bladder-worms, and consists of a number of transparent ovoidal sacs, attached by a short stalk at one end, and having at the other a short funnel-like depression. Each sac is the *caudal* cyst of a cystic worm; the latter consisting, besides this vesicle, of a head and body. The head is provided with four suckers and a circlet of hooks, and is invaginated within the oval body, which represents the posterior part of a scolex, and is itself invaginated into the caudal cyst, the funnel-like depressions at the free extremity of which allow of the extrusion of the head and body.

Each colony proceeds, by a process of budding, from a simple vesicle or *blastogen*, the result of the metamorphosis of an ovum of *Tænia*. The ova, passed out of the body of the shrew with the fæces, are taken in by the myriapod, and probably make their way from the alimentary canal into the Malpighian tubes, finally penetrating the walls of the latter, and taking up their abode in the surrounding adipose tissue. If the *Glomeris* is then eaten by a shrew, the head and body are extruded from the caudal cyst, and proglottides are formed by budding from the scolex in the usual way.

Besides its life-history, Villot gives an account of the histology of *Staphylocystes*.

Echinodermata.

"Comet-forms" of Starfishes.*—The "corm theory" of Professor Haeckel, according to which, as is well known, that distinguished zoologist believes that it is alone possible to give any reasonable explanation of the characters of the Echinoderms, is forcibly supported by the arguments and facts which he brings forward in a paper under the above title.

In the historical introduction he points out that three explanations have been given of the problem raised by the organization of the adult Echinoderm; the first, and earliest, was propounded by Cuvier, who, insisting on the *radiate* character of their organization, placed them with the Hydroida, the Medusæ, and the Ctenophora; the two Professors Agassiz, father and son, have done their best to further this view, and the Russian zoologist Metschnikoff has not been behind. In the year 1848, a year famous in the annals of zoology, as being that in which Frey and Leuckart separated the Cœlenterata from the rest of the "Radiate mob," a new view was taken, inasmuch as these authors, more especially Leuckart, regarded the Echinoderms as having their closest allies with the Worms, and especially with the

* 'Zeitschr. wiss. Zool.,' xxx. (Suppl.) (1878) p. 424.

Gephyrea; as to these latter, we find the following striking points of resemblance between them and the Holothuroid Echinoderms: the "sausage-shaped" elongated body is enclosed by a firm and naked integument; the mouth opens at the anterior and the anus at the posterior pole, while in both cases the former is surrounded by a circlet of tentacles; nor is the resemblance confined to their external characters, in both cases a pair of "tree-like" organs are connected with the rectum of a large number of forms. Many of what are now called Gephyrea the earlier zoologists placed, indeed, with the Holothuroida, and the view that there is a close relationship is still held by a number of zoologists, of whom Professor Claus is cited by our author.

The third view is that put out by Professor Haeckel. The similarities between the Holothurian and the Gephyrean are due to the action of similar external circumstances, and not to descent or close genetic relation—they are not *homologies*, but only *analogies*; thus the tree-like organs are primitively five in the one, and primitively two in the other group; the arrangement of parts is *dipleural* in the one, and *pentamerous* in the other; the Echinoderms are, in fine, pentate colonies of worm-like or dipleural persons, each of which is comparable to a segmented worm; the history of these forms is only rendered intelligible when we regard the bilaterally symmetrical larva as a nurse, and look upon the history of their development as involving an alternation of generation. This view is supported by Sars, both father and son, by Gegenbaur, and by Lange.

To turn to the "Comet-forms" which in Professor Haeckel's opinion support these views; these are those starfishes in which a separated arm has produced afresh the central disk and the other arms. It is impossible for us to give an account of the observations of Martens, Kowalewsky, Sars, and Studer, but those of Sir John Dalyell may well be taken as a type; on the 10th of June this observer found an arm, which had evidently been lately separated from a starfish; five days afterwards four new rudimentary rays appeared on it; on the evening of the same day (the 15th) a new mouth began to be formed, and on the 18th the animal was again completely developed, save only that the four new arms were very small; a month afterwards the animal spontaneously freed itself of its original arm. The true comet-form is always distinguished by one completely developed arm, to which, at its central end, the newly formed disk and four or five arms are connected; at first there is no disk, and no madreporic plate, while the mouth is formed by the open central end of the primary arm. When the new arms have attained a certain size, a small median disk appears, the mouth takes up a central position, and a small madreporic plate appears on either side of the primary arm. These observations lead to the following law, from which there seems to be no escape. In certain Asteroida the arms break off spontaneously from the disk, and each separated arm reproduces the whole disk and the other arms. Further observations show that the point of fissure is so placed that a small portion of the lost arm

remains connected with the disk, and here a new arm may be developed.

If these observations are not shown to be altogether misreported, it will follow that there are in the Echinoderms two modes of metagenesis; the one in which the so-called "larva" (*Pluteus*, *Bracholaria*, &c.) functions as the nurse, and produces the Echinoderm by *internal* gemmation, and the other, more rare, in which the spontaneously separated arm functions as a nurse and produces the sea-star by *external* gemmation.

These facts, in Professor Haeckel's opinion, largely confirm his "corm theory." Dealing with Metschnikoff, who regards the arms of the starfish as comparable to those of the cephalopod, he points out that no cephalopod arm, no lizard's tail, no crab's limb, ever produced a crab, cephalopod, or lizard; and he further insists on the high development of the locomotor apparatus of the Echinoderms. To help forward the discussion, Haeckel proposes the name of *Astrotithene* (τιθήνη = a nurse) for the larval, and *Astrocormus* (κορμός = a colony) for the adult starfish; the former is an unsegmented bilaterally symmetrical person, the latter is made up of five *parameres*, each of which is composed of two symmetrical *antimeres*; in the adult there is further to be distinguished the *astrodiscus* made up of five congruent parameres (or five pairs of antimeres), and five *astrolenæ* (ωλένη = an arm), each of which is composed of a pair of antimeres. Traced in their developmental history, we see the multiplication of the organism; looked at genetically, we find the ancestor of the astrotithene in an unsegmented worm, most nearly allied to the Rotatoria and the ciliated larva of the Annelides.

The paper concludes with dividing the Echinoderms or Estrellæ into three primary classes (subphyla), and six classes.

Subphylum 1. *Protestrellæ*. *Estrellæ* without internal centralization, with complete morphological autonomy of the astrolenæ; enteric system consisting of a simple central intestine, and five (or more) bifurcated special intestines. 1st class, *Asteriæ*.

2. *Anthestrellæ*. *Estrellæ* with partial internal centralization; the proximal portion of the astrolenæ together with the whole of the enteric system pass into the central astrodiscus; no special intestines. 2nd class, *Ophiuræ*. 3rd class, *Crinoida*.

3. *Thecestrellæ*. *Estrellæ* with complete internal and external centralization; the five astrolenæ pass completely into a single spheroidal or tubular astrodiscus; no special intestines. 4th class, *Blastoida*. 5th class, *Echinida*. 6th class, *Holothuriæ*.

Professor von Martens, whose descriptions of Echinoderms are among the most valuable, has a note * on this subject. Speaking of the great difficulties connected with Haeckel's hypothesis, he points out that the arm of the sea-star contains all the representatives of all the essential organs of the animal, and that we know of no other example of a compound animal with a common mouth and all the other organs separate, but that in all cases where a colony is formed by gemma-

* 'Naturforscher,' xii. (1879) p. 103.

tion, the mouth or the end corresponding to the mouth is peculiar to each separate animal, and does not form part of the common colony.

Genital Organs of Asterina gibbosa.*—Dr. Hubert Ludwig, who has devoted considerable time to the study of the Echinoderms, now reports that, in the examination of the generative organs of the Asteroida, he has come across a very remarkable and quite unexpected arrangement. In all cases which have as yet been observed, the genital organs of the Asteroida have been found to open on the dorsal surface of the disk, and zoologists were coming to believe that this arrangement was an important aid in distinguishing between the Sea-stars (Starfishes proper) and the *Ophiurida* (Brittle-stars); it was therefore a matter of some astonishment to find in *Asterina gibbosa* Forbes (= *Asteriscus verruculatus* M. Tr.) the genital orifices on the *ventral* side, and that the more since in *Asterina pentagona* E. v. Martens they are on the dorsal side. The first supposition that the arrangement was "pathological" was corrected by the examination of twelve specimens; in all of these it was observed that in every inter-radial region there were two slit-like pores, set symmetrically to the median plane of the interradius, and parallel to the adjacent ambulacral groove. Counting from the corner of the mouth, we find the slits between the fifth and sixth interambulacral plates; each opening leads into a canal, the inner surface of whose walls is thrown into longitudinal folds; this canal passes in a curved direction to the dorsal wall of the body, where it enters the basal portion of the genital tubes; these latter, it should be observed, have just the same position as in *A. pentagona*.

It is somewhat difficult to imagine what has caused the difference in the position of the pores, but Dr. Ludwig imagines that they have merely changed their position in *A. gibbosa*, and that it is not a newly developed arrangement. The allied species, *A. cephæa* Edm. Perrier, has been examined, and has been found to have the genital pores dorsal in position, while the species of F. Gasco, *A. panceri*, is shown to be merely a variety of *A. gibbosa*. *Palmipes membranaceus* is reported to have been examined by Gasco, who did not find the genital orifices on the ventral surface; but as this author does not seem to have been struck by the peculiarity exhibited by *A. gibbosa* as compared with the rest of the Asteroida, it is only possible to say of it that its genital orifices have not yet been observed.

Anatomy of Brisinga.†—Dr. Ludwig also contributes a paper on this most interesting form, which is regarded by Sars, its discoverer, as forming the type of a special family of the Asterida, and by Professor Gegenbaur as the representative of a group distinct both from the Asterida and Ophiurida.

Dealing first with the blood-vascular system, as to the existence of which Sars was not able to convince himself, the author commences by recapitulating the results of his investigations on the

* 'Zeitsch. wiss. Zool.,' xxxi. (1878) p. 395. † Ibid., p. 216.

vascular system of the Asterida; this consists of the following parts:—

1. An oral blood-vascular ring placed in the peristom.
2. A dorsal blood-vascular ring.
3. A vascular plexus connecting these rings—the so-called heart.
4. A radial vessel given off from (1) to each arm.
5. Vessels given off from the dorsal vascular ring, and passing to the generative organs.
6. Two gastric vessels given off from the dorsal vascular ring.

To turn to what obtains in *Brisinga*, and following the author in first discussing the genital vessels, which are the easiest to find, we discover a vessel to the right and to the left of the series of joints of which an arm is made up; as it reaches the genital organs this vessel nearly doubles in breadth; examined in cross section, it is seen to contain a plexus of vessels, so that it is a "peri-hæmal canal"; the plexus has just the same characters as in the rest of the Asterida, save only that it is more distinctly plexiform; in its terminal characters it exactly resembles the genital vessels of the true sea-stars. The radial blood-vessels were examined by the aid of sections made through decalcified arms, and were found to be in all essential characters exactly similar to the same parts in the Asterida; the same is the case with the vascular apparatus of the disk; therefore we are relieved from describing it here.

On the dorsal aspect of the disk Sars observed a pore, which was subcentral in position, but which he only regarded as the orifice of an excretory apparatus, as he was unable to discover any connection between it and the enteric tract. Ludwig now shows that this pore communicates with the lumen of the interradial cæcal sacs, which are given off from the stomach, and which are shown by further examination to be nothing else than processes of the rectum, so that the pore is a veritable anus. In another point, also, Ludwig extends the observations of Sars, to make which clear it is necessary to draw attention to the fact that our author, in his examination of the peristomial skeleton of the Asterida, has discovered that the first two joints of the arms undergo more or less complete union. Now, according to Sars, this region consists of two joints, with their adambulacral plates, for each radius, and two paired "dorsal marginal plates" for each interradius; while there are, in addition, in each interradius, two "parietal" plates; these last are now shown to be the first and metamorphosed joints, and, just as in the rest of the Asterida, the so-called first joint is really double, for Sars erred in regarding them as interradial instead of radial.

A few words must be said as to that peculiarly interesting structure—the stone canal. A series of transverse sections has demonstrated that, as in all other *Asterida* which have as yet been examined, it commences by a simple lumen; just as in *Echinaster fallax*, its structure is not at all complicated, as it is, for example, in *Asterina pentagona*; its investing epithelium is high and ciliated, and the cuticle is traversed by small but quite distinct pore-canals for the passage of the cilia, and each pore-canal seems to belong to a proper epithelial cell.

As may now be supposed, Ludwig inclines to the view of Sars

rather than to that of Gegenbaur, with respect to the systematic position of *Brisinga;* the classification of the latter is based on two reasons, one of which is that in *Brisinga*, as in the Ophiurida, the enteric tract does not send cæca into the anus; but it has lately been shown that they do extend along the first third of these parts; while to the second reason, that the arms of *Brisinga* are separated from the disk, is opposed the statement that the Ophiurid appearance is due to the small (three) number of joints which pass into the skeleton of the disk. The difference insisted on by Sars as obtaining between *Brisinga* and the other *Asterida*, the absence of respiratory processes, is regarded as being of small moment, on account of the extreme tenuity of the integument in this form; while the ancient character of the creature is not regarded by Ludwig as being in any way distinctly proved. This very interesting and important paper is illustrated by a plate of twelve figures.

Aspidura.*—Dr. Hans Pohlig gives a fresh definition of this interesting Triassic Ophiurid, from the muschelkalk of Germany, which he divides into two subgenera, *Amphiglypha* and *Hemiglypha*, of which the former is broader and has shorter arm-spines than the latter; in each case a single species is alone known. He regards this form, which is the only Ophiurid as yet found in this stratum, as representing an extinct genus, which is distinguished from all its allies by the possession of larger, closely connected, radial shields, and by the bilateral groove on its oral shields; belonging to the Ophiolepidæ, it is intermediate in character between *Ophioglypha* and *Ophiopus*. *Hemiglypha* has many points of resemblance to the Asterida, and appears to occupy a similar position among the Ophiurida to that held by *Brisinga* among the Asterida.

It may be interesting to observe that Pohlig agrees with Haeckel in regarding the Asterida as the older forms.

Cœlenterata.

Classification and Phylogeny of Actinozoa.†—Dr. W. Haacke, of Jena, gives a supplement to his paper in the current volume of the 'Jenaische Zeitschrift,' in which he proposes the following classification of *Actinozoa*:—

A. DIASEPTIGERA ..	I. *Corallarcha* ..	1. Protocorallida.
		2. Tetraseptata.
	II. *Octocoralla* ..	3. Alcyonida.
		4. Tubulosa.
		5. Gorgonida.
		6. Pennatulida.
	III. *Heterocoralla* ..	7. Cereanthida.
B. ZYGOSEPTIGERA ..	IV. *Tetracoralla* ..	8. Tetractinida.
		9. Rugosa.
	V. *Hexacoralla* ..	10. Actinida.
		11. Antipatharia.
		12. Tabulata.
		13. Perforata.
		14. Aporosa.

* 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 235.
† 'Zool. Anzeiger,' ii. (1879) p. 261.

The *Cerianthida* are separated from the *Hexacoralla*, with which they are usually associated, from the fact that their sarcosepta (mesenteries) are not arranged in pairs the number of which is half that of the tentacles; in this respect they agree with the *Octocoralla*.

The subdivision *Corallarcha* is an entirely hypothetical one, made to contain the supposed stem-forms of the Actinozoa, with an indeterminate number of sarcosepta (*Protocorallida*), and those in which the number had become fixed at four (*Tetraseptata*). This latter group is taken to be quite distinct from the *Tetractinida*, the hypothetical ancestors of the *Rugosa*, in which the number of sarcosepta was at least eight.

The author gives the following genealogical tree of the class:—

Diaseptigera.		Zygoseptigera.
Heterocoralla.	Octocoralla.	Hexacoralla.
	Tetraseptata.	Tetracoralla. Tetractinida.
	Protocorallida. Corallarcha.	
	Archydra.	

New Paludicolous Medusa.*—The *Medusæ* are almost exclusively pelagic zoophytes, inhabiting the open sea, and they dread nothing more than fresh water, which is a destructive poison to them. Even brackish water kills them instantaneously. Moreover, they constantly need a water rich in oxygen, fresh and incessantly renewed by the perpetual movement of the waves and currents. The *Medusæ*, in fact, have an almost equal dread of fresh water, of stagnant sea-water, and of a slightly too high temperature.

All these considerations will enable the reader to understand, says Dr. Du Plessis, how he was surprised, at the end of the month of June, 1876, at finding, in the middle of the discharging canal of the saltworks of Villeroy, near Cette, a charming *Medusæ* of a new species, which inhabits these salt marshes in the summer. It belongs to the genus *Cosmetira*, a section of the numerous group of the Oceanidæ; and it is curious that it is a miniature copy of a much larger species, *Cosmetira punctata*, which occurs frequently in the sea near Cette, and at Nice, Naples, and elsewhere.

The interest possessed by this creature is concentrated in the novel conditions to which it must have accommodated itself to be able to exist in the locality where it is now met with. The canal is not more than two or three metres broad, and not more than one metre deep. The soil is a black putrid mud, stinking of sulphuretted hydrogen. The water is perfectly stagnant and very brackish. It is without any shade, is almost all day long exposed to the burning sun of Languedoc, and often exceeds 77° F.

The *Medusa* always inhabits the lower surface of islets of floating

* 'Bull. Soc. Vaud. Sci. Nat.,' xxi. (1879) p. 39.

algæ. On removing these it is seen clinging like a flake of jelly, shining like crystal. The season of their occurrence is limited to June and July. They were not found in September and October, any more than in the spring.

Every zoologist who has attempted to keep these creatures in captivity has been reduced to despair by seeing them perish in a little time, whatever may have been done to render the aquarium comfortable for them. But this marsh species, forced no doubt by vital competition to accommodate itself very gradually to great vicissitudes, has become hardened by this process; and the proof of this is that it may be very well preserved for weeks together in the smallest bottles, with a few hundred grammes of the water of the canal and a few green algæ to keep up a small supply of oxygen. Under these circumstances, specimens have been transported with the greatest facility from Cette to Lausanne, and kept there for months without the least trouble. This species, being so accommodating, will be very welcome to those who desire to observe these animals for a long time in captivity. *Cladonema radiatum* Duj., and other microscopic *Medusæ*, also bear captivity, but these are scarcely visible to the naked eye, whilst this, being of the size of a half-franc (Swiss money), is much more suitable for all sorts of manipulation.

Moreover (and this is the most interesting point), it presents one of the clearest examples of the influence of the circumambient medium upon the gradual modification, and finally, transformation of one species into another; for certainly our *Medusa* has originated from an importation of the large *Cosmetira punctata*, the form of which it reproduces on a small scale, repeating its whole organization *en diminutif*. Thus reduce the larger animal to the dwarf size of a half-franc piece, colour the canals and the stomach green, change the rose-colour into violet, blacken the tentacles, and you have by these modifications transformed the *Cosmetira* of the sea into that of the salt marshes.*

Charybdea marsupialis.† — This *Medusa*, which lives at the bottom of the sea, and exhibits a large amount of asymmetry, is interesting especially on account of the different reports given of it by Gegenbaur and Fritz Müller. Difficult to obtain, its structure and its systematic position have long remained uncertain: it was distinguished by F. Müller from the genus *Tamoya*, on account of the following characters; the edge of the bell (velum) was divided into lobes, the stomach was provided with accessory canals, the "grappling lines" opened into the lateral canals and not into the lateral pouches, the stomach and oral infundibulum were confluent, and the gastric filaments hollow and not solid.

Professor Claus now states, that in the first three points *Charybdea* does resemble *Tamoya*, that point four is of no value, and that as to the hollow filaments connected with the stomach there are no such in any *Medusa;* they are, in fact, always solid. The ectodermal investment is reported as having just the same characters as in other

* 'Ann. and Mag. Nat. Hist.,' iii. (1879) p. 385.
† 'Arbeit. Zool. Inst. Univ. Wien,' ii. (1878) art. 2.

Acalephæ; as in all Craspedota, there are transversely striped muscle-fibres in the subumbrella and velum, and smooth fibres on the surface of the lobes of the umbrella, and internally to the gelatinous layer of the tentacles. All these muscle-fibres are products of the ectodermal cells, and are in connection with them. Circular muscles are not present except in the subumbrella and in the corresponding surface of the velum; the fibrous layer which invests the supporting lamella of the subumbrella is, at the four radii, broken into by radial fibres, which are not transversely striated. The Charybdeidæ do not merely show their relationship to the Craspedota by the presence of a velum, but also by the characters of their nerve-ring; this structure is, however, remarkable for its position at some considerable distance from the edge of the umbrella and by its great size; at the base of the marginal bodies the nerve-ring is exceedingly well developed. The mode in which its fibres enter into the conical basal portion of the marginal body is a matter of some difficulty; it might be supposed that they passed through the tissues of the wall of the bell, and through the supporting lamella of the subumbrella with the parts connected thereto; as a matter of fact, their course is simple, for so soon as they have passed the supporting plate they immediately bend towards the epithelial surface of the base of the marginal body. Through his further details of these and of the other sensory organs we have not space to follow the author.

As to the gelatinous substance of *Charybdea*, it is shown to want those oval or star-shaped cells which are found in so great abundance in the similar parts of *Rhizostoma*, *Aurelia*, and *Discomedusa;* but the rigidity of the structure is clearly increased by the number of fine elastic fibres which go to make it up. The endodermal epithelium varies greatly in character according to its position; it may be said, as a general rule, that in the Craspedota the superiorly lying epithelium of the umbrella consists of flat cells and the inferior of cylindrical cells; the changes which are seen in it at the points where the substance of the gelatinous matter of the umbrella unites with the supporting lamella of the subumbrella are very interesting; contrary to what happens in the Acalephæ and Craspedota, the bands are here delicate, and the radial vessels consequently form, as in Lucernaria, wide pouches. In the gastric wall of the subumbrella the endodermal cells are high and cylindrical, while the character of their contents leads us to suppose that this epithelium, like that of the small intestine of higher animals, is able to absorb albumen; at the surface of the oral infundibulum the cells are not so high, and enclose a number of goblet-shaped cells, while on the oral disk the epithelial cells are cylindrical in shape and provided with rounded ends; it is probable that they secrete a digestive ferment. Treating shortly of the generative organs, Professor Claus comes finally to the conclusion that the position he had already assigned to *Charybdea* is the right one.*

Halistemma tergestinum.†—In describing this new species, Claus takes the opportunity of making some general observations on the

* See this Journal, ii. (1879) p. 431.
† 'Arbeit. Zool. Inst. Univ. Wien,' i. (1878).

histological characters of the Physophoridæ. The form under description was observed at Trieste, and in nearly all its most important characters agrees with the other species of *Halistemma;* of this group it would be one of the smaller representatives, as its whole length is not more than ten inches. The stem, as in all Physophoridæ, is spirally coiled, and this spire follows two directions; on the axis of the stem and at the base of the tentacles and of the gonophores there are irregularly stellate spots of a red colour, which is most distinctly marked on the male gonophores.

Our space does not permit us to enter into the details of this paper, and we must leave it with some brief remarks. The swimming bells of this form are noted as being considerably smaller towards the superior pole and the inferior end of the swimming column, and as presenting a bilateral symmetry so distinct that they may well be called dorsal and ventral; as compared with the body of the Hydromedusæ, the bell of the Siphonophora displays many very striking points of agreement, not only in its histological structure, but in its mode of development. In *Halistemma* the male and female buds are reported as appearing on each tentacle, where they form distinct racemose groups, placed on a short stalk; their medusoid structure is feebly developed; the male medusoids, which are distinguished by their reddish-brown pigment, are, when mature, set free from the stalk, and for some time swim about freely by the aid of a rich supply of cilia; the female buds are, so far as Claus has observed, devoid of pigment; the egg is relatively large, and has a large germinal vesicle with a nucleolus which is ordinarily homogeneous; this body always lies close to the distal pole, and appears to leave the egg when this is matured.

The view that the Siphonophora are polymorphous, first put out by Leuckart, has been opposed by that of Professor Huxley, who regards the various appendages of the Siphonophora as organs of a *Medusa;* this latter view has been lately and independently supported by P. E. Müller and by Metschnikoff; the processes of development do indeed seem to bear out their conclusions, but Professor Claus points out that the presence of an air-sac, which has a tendency to be repeated, seems rather to point to the Siphonophore being a complex of self-repeating parts of a *Medusa*, and therefore to confirm the view of the polymorphism of these animals; the whole difficulty lies perhaps in the conception of the "person" and of the "colony"; in these forms, as in the Cestodes, the difference is not one that is to be insisted upon, but is one rather that is most marked when they are regarded comparatively.

Tubularia mesembryanthemum.*—An exhaustive study of the histology and embryology of this species has lately been made by Ciamician.

1. *Methods.* For examination of the tissues as a whole, the author recommends treatment with 0·25 to 0·05 per cent. osmic acid; for isolation of the separate elements of the tissues, maceration in 1 per cent. chromic acid, staining with eosin, and teasing out in glycerine.

* 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 323.

2. *Histology.* The fibres of the mesoderm, instead of being, as in *Hydra*, mere processes of the ectoderm cells, are independent spindle-shaped muscular cells with nuclei. *Tubularia* has thus the most differentiated mesoderm of all the hydroid polyps, the simplest conditions being represented by *Hydra*, *Syncoryne*, and *Podocoryne*, while *Hydractinia* affords an intermediate state, its muscle-fibres having separate nuclei, but being in connection with the ectoderm cells. There are two layers of muscular fibres in *Tubularia*, an inner longitudinal layer, in contact with the gelatinous connective lamina, and an outer transverse or circular layer.

An account is given of the mode of formation of the thread-cells. The cnidoblasts or smaller ectodermal cells in which these are formed, are in direct continuity by means of fine protoplasmic processes with the muscular fibres of the mesoderm. The thread-cells begin as a sort of vacuoles in these cnidoblasts, in the neighbourhood of the nucleus, but soon increase until they fill the cell. In all Hydrozoa yet observed, the protoplasm of the cell is entirely absorbed *pari passu* with the development of the thread-cell, but in *Tubularia* Ciamician finds that a small portion of protoplasm surrounding the nucleus becomes separated as a distinct cell, which may then itself give rise to a new thread-cell.

The connective lamina (Stützlamelle) which lies between the muscular layer and the endoderm, can be isolated by long maceration in water and in ammoniacal solutions of carmine. The side turned towards the mesoderm is seen to be smooth, while the inner side is indented, the indentations corresponding to the large endoderm cells. It is very resistent, about 0·003 mm. thick, and shows no structure under the highest powers.

3. *Ontogeny.* The development of the gonophore is first considered, but little is added to the author's former paper,* except a more exact account of the mode in which the spadix breaks through the distal wall of the gonophore, and a description of structures, in the latter, which evidently represent the marginal tentacles of a medusa. These occur in the form of eight elevations arranged in a circle, at the distal end of the gonophore, around the projecting spadix; they are formed from the combined ectoderm and "medusoid lamella" (the double layer of invaginated endoderm) of the wall of the gonophore.

As in *Hydra*, only a few (four to eight) egg-cells in each gonophore attain maturity, and become actual ova; the remainder serve as food-material for them. As in *Hydra*, also, sharply defined protoplasmic spheres (*pseudo-cells*) appear amongst the clear yolk-spheres of the egg, and these, Ciamician finds, multiply by a process of division, which process, however, does not resemble these cell-divisions, but is rather like a falling to pieces of the pseudo-cell. The egg is devoid of a vitelline membrane.

The interesting observation is made that some of the undeveloped egg-cells may undergo division from true seminal cells.

The process of yolk-division was actually followed in the living

* This Journal, ii. (1879) 66.

ovum. The first cleavage furrow is vertical, the second equatorial, the egg becoming divided into two micromeres and two macromeres. Both of these undergo further multiplication, and the micromeres gradually grow round the macromeres (epiboly), forming the epiblast or primitive ectoderm, while the included macromeral cells constitute the hypoblast or primitive endoderm.

The solid oval embryo thus formed elongates until it acquires a fusiform shape; the two ends of the spindle being the rudiments of the first two tentacles. The gastro-vascular cavity is formed as an excavation in the solid mass of endoderm.

The author further traced the changes by which the newly freed larva (Actinula) is converted into the attached *Tubularia* polyp; he describes the gradual differentiation of the larval body into hydrocaules and hydrorhiza, the formation of the perisarc, &c.

Protozoa.

Tintinnus semiciliatus, a new Infusor.*—Dr. V. Sterki describes a new species of the genus *Tintinnus*, found by him at Schleitheim, in Switzerland.

The body is of a wine-glass shape, truncated anteriorly, and behind passing gradually into a long stalk by which it is attached to the bottom of its tube. The animal was sometimes found without its tube; whether this was an accidental or a normal state of things is uncertain; when free the stalk was always wanting, the posterior end of the body being rounded off, or, at most, was represented only by a small stump. In some cases a constriction was observed near the posterior end of the body; probably this was due to pressure, not to commencing division. The length of the body without the cilia is 0·04 to 0·06 mm., with the stalk 0·1 to 0·12 mm., the diameter 0·03 mm.

The anterior end of the body is surrounded by a raised circular rim of firm consistency, from which spring the fifteen to twenty large adoral cilia or membranelles, each of which is flat and band-like, inserted obliquely on the rim, and split up distally into about six filaments. Round the inside of the rim, near its base, is a row of shorter, fine cilia of the ordinary character, and perhaps homologous with the paroral cilia of *Oxytrichina*.† Also the anterior or free half is sparsely covered with short, fine cilia.

Within the ciliated rim, the anterior end of the animal is slightly convex, quite soft, and presents an irregular depression or peristomial space, without, however, any distinct mouth or gullet. Neither cilia nor undulating membrane occur in the peristome, but its inner wall undergoes continual movement, acting like a sort of lip or tongue. This fact is interesting as showing the possibility of independent movement on the part of the soft endosarc or internal parenchyma.

The body-substance is clear and slightly yellowish. There are no muscle-striæ, and no discoverable structure in the stalk. In the posterior end of the oval nucleus is a strongly repeating globular

* 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 460.
† See this Journal, ii. (1879) p. 91.

body, probably representing the nucleolus. There is a single contractile vesicle, near the peristome. Many "serous" spaces are also to be seen. No anus could be discovered.

The development was not made out, although the author had evidence that multiplication takes place by transverse fission. The tube is formed by the animal out of bits of decaying plants, and small fungoid and algal filaments.

Blepharisma lateritia.*—A short note on the conjugation of this infusor is contributed by Duncker, of Berlin. He states that the process lasted for about an hour, and that while it was going on the nucleus appeared to move somewhat farther backwards. On one occasion two individuals in conjugation were seen to make vigorous efforts to separate themselves by swimming backwards against the grains of sand found in the fluid; these seemed to act as wedges between the two animals, gradually prising them apart; the separation being effected after forty or fifty attempts. The separated animals, or at least one of them, showed a degeneration of the nucleus, the further changes in which were not observed. Red masses were, however, found in the vessel, which bore a close resemblance to the altered (? impregnated) nucleus, and were possibly germ-masses, although no movement was observed in them, and they were not seen to develop further.

Haptophrya gigantea, a new Opalinid from the Intestine of the Anourous Batrachia.†—The intestine of Batrachians harbours a whole world of parasites, which live and multiply with a truly surprising abundance. Microscopists especially may thus make the finest harvests of Infusoria and Bacteria. M. E. Maupas says that he has often examined the contents of the intestine of *Bufo pantherinus*, *Discoglossus pictus*, and *Rana esculenta*, from Algiers, and always found them richly populated. He was able to recognize the following species: *Nycthotherus cordiformis*, *Balantidium elongatum*, *B. entozoon*, *Opalina dimidiata*, *O. intestinalis*, *O. obtrigona*, and *O. ranarum*. With these large ciliated Infusoria swarmed myriads of Bodos, Monads, Amœbas, Bacilli, Vibrios, and Bacteria. All these species are European, but he also very often found in the intestine of the *Bufo* and the *Discoglossus* (less frequently in the frog) a very fine species of Opalinid, which appears to be undescribed, and which, from several very curious details of its organization, must greatly interest protozoologists.

This Opalinid may be regarded as the giant of the Infusoria, for individuals were measured the length of which exceeded 1 mm. The body has a very elongated cylindro-conical form, tapering from the front backwards. The anterior extremity is pretty strongly depressed, and is nearly twice the breadth of the posterior region, which measures from ·08 to ·09 mm. This depressed portion is occupied by a circular sucker, formed by the retreat inwards of the wall of one of the broad surfaces, which may be called the *ventral surface*. The action of the sucker is ensured by cords of sarcode, which start from

* 'Zool. Anzeiger,' ii. (1879) p. 260.
† 'Comptes Rendus,' lxxxviii. (1879) p. 921.

its inner wall, and attach themselves to the opposite dorsal wall. The concavity caused by the traction of these cords is of course very slight, but nevertheless clearly visible with the Microscope. The animalcule attaches itself to objects by means of this sucker. The surface of the body is covered with very close rows of cilia. Four or five rows may be counted in ·01 mm., and in the concavity of the sucker they are half as numerous again. The cilia, whose length is ·005 mm., are very close together, about thirteen or fourteen in ·01 mm. These cilia are the only organs of locomotion, and the progress of the animal is never very rapid.

The integument or ectosarc has a thickness of ·045 mm., and is composed of two very distinct layers—one external, in which the prolongation of the cilia may be followed in the form of bacilli, the other internal, composed of transparent and absolutely amorphous sarcode. This integument is entirely destitute of proper contractility, so that the animalcule cannot in any way modify its form spontaneously; but on the other hand it possesses great elasticity, which allows the body to resume immediately its normal contour when modified by an obstacle. The endosarc is composed of clear and liquid sarcode, at the periphery of which exists a layer of large, opaque granulations.

The nucleus is free in the general cavity, and following the movements of the body, can move from one extremity to the other. Its form is that of a very elongate and rather flat ellipsoidal shuttle; it may measure as much as ·185 mm. Its substance consists of an opaque, slightly yellowish gangue, in which are seen numerous spherical corpuscles of nucleolar appearance. When, from the crushing of the body, a fresh nucleus is placed directly in the water, its substance contracts, and at the surface there appears a fine amorphous membrane, as in many other Infusoria.

The body is traversed throughout its length by a long contractile canal attached to the dorsal face, the pulsations of which, from one systole to the next, last a little more than a minute. This canal is not rectilinear, but describes numerous sinuosities irregularly disposed. Its diameter in diastole is ·018 mm. It is furnished with proper walls, and thus constitutes a true vessel. By this character it differs from the contractile vacuoles of the other Infusoria, which are only temporary cavities hollowed out in the endosarc. The wall of the vessel, visible even in the living animals, becomes still more apparent with coagulating reagents. This vessel, moreover, is provided with orifices, which traverse the integument and open outwards in the form of very clearly visible pores in the midst of the rows of cilia. These pores place the vessel in communication with the exterior, and serve for the exit of the interior liquid at the moment of systole, and very probably for the entrance of the exterior liquid during diastole. The pores, seven or eight in number in the large individuals, are placed exactly in a straight line at irregular distances on the course of the vessel. They are of an oval form, and measure ·003 mm. in length.

This Infusor multiplies by dividing transversely into segments. The segmentation is at first indicated at the middle of the length of

the body by a clear band in the endosarc. The nucleus divides in two, a constriction contracts the body at the point of segmentation, and the vessel becomes divided into two. The two segments remain united together. The same operation is repeated, for a first time, at the middle of each of the segments, so that we see four segments soldered together, then a second time at the middle of each of these four new segments, and the body is cut into eight segments still attached to one another, and completely recalling by their external aspect and arrangement the zoonites of the Tæniæ. These segments then separate, and many of them are always found isolated in the rectum of the hosts.

This fine Infusor much resembles the Opalinid found by Von Siebold in *Planaria torva*, and figured by Max Schultze under the name of *Opalina polymorpha*. If we adopt the generic divisions established in the family of Opalinida by Stein, it will have to be placed by the side of this latter species in the genus *Haptophrya*. On account of its large size, M. Maupas names it *H. gigantea*.

Stein's 'Organismus der Infusionsthiere.' *—After an interval of eleven years, the first part of the third volume (comprising the Flagellate Infusoria) of this work has appeared. It is the result of long and patient original investigation, and constitutes, as the author says, the most laborious of his productions. The second part, containing the characters of the genera and description of the species, is announced as shortly to follow, completing the work.

The following is the classification adopted by Stein for Infusoria which move by means of flagelliform filaments. It will be seen that, returning to the traditions of Ehrenberg and of his school, he brings back to the animal kingdom a number of organisms that most modern authors consider as of a vegetable nature.

Infusoria Flagellata.

1. *Monadina.*
   Cercomonas; Monas; Goniomonas; Bodo; Phyllomitus; Tetramitris; Trepomonas; Hexamita; Lophomonas; and Platytheca.
2. *Dendromonadina.*
   Dendromonas; Cephalothamnium; Anthophysa.
3. *Spongomonadina.*
   Cladomonas; Rhipidodendron; Spongomonas; Phalansterium.
4. *Craspedomonadina.*
   Codonosiga; Codonocladium; Codonodesmus; Salpingœca.
5. *Bikœcida.*
   Bikœca; Poteriodendron.
6. *Dinobryina.*
   Epipyxis; Dinobryon.
7. *Crysomonadina.*
   Cœlomonas; Rhaphidomonas; Microglena; Chrysomonas; Uroglena; Syncrypta; Synura; Hymenomonas; Stylochrysalis; Chrysopyxis.

* M. J. Deby in 'Bull. Soc. Belg. Micr.,' v. (1879) p. 99.

8. *Chlamydomonadina.*
   Polytoma; Chlamydomonas; Chlamydococcus; Phacotus; Coccomonas; Tetraselmis; Gonium.
9. *Volvocina.*
   Eudorina; Pandorina; Stephanosphæra; Volvox.
10. *Hydromorina.*
   Chlorogonium; Chlorangium; Pyramidomonas; Chloraster; Spondylomorum.
11. *Cryptomonadina.*
   Chilomonas; Cryptomonas; Nephroselmis.
12. *Chloropeltidea.*
   Cryptoglena; Chloropeltis; Phacus.
13. *Euglenida.*
   Euglena; Colacium; Ascoglena; Trachelomonas.
14. *Astasicæa.*
   Eutrepia; Astasia; Heteronema; Zygoselmis; Peranema.
15. *Scytomonadina.*
   Scytomonas; Petalomonas; Menoidium; Atractonema; Phialonema; Spenomonas; Tropidocyphus; Anisonema; Colponema; Entosiphon.

Stein places *Volvox*, *Eudorina*, *Pandorina*, *Euglena*, and even *Chlamydococcus pluvialis* amongst the Flagellate Infusoria, on the ground principally of the presence of a contractile vesicle. His observations on the multiplicity of *Volvox* and analogous genera confirm those of Cohn.

Stein accepts the views of Clark on the nature of sponges, and gives figures of a great number of new species of Infusoria discovered by him, which seem to establish incontestable links between the Flagellate Infusoria and the true sponges.

He does not appear to have verified or even to have known of the observations of Dallinger and Drysdale on the life-history of Monads.

Effect of Light on Pelomyxa.*—In a very low, amœba-like organism, *Pelomyxa palustris*, Herr Engelmann recently observed a remarkable action from sudden incidence of a moderate light. Watched in the Microscope, this organism showed very slow movements, which, however, on shading the object, became much more lively. When the hand was removed the glandular mass in the interior became still, and the body contracted into a ball, as after an electric shock; this effect occurred within a few seconds. With continued moderate light, weak changes of form appeared again, with hardly perceptible locomotion. This experiment was several times repeated with equal success, and the results were especially notable in a dark room, into which diffused daylight could be admitted. When, however, the room was illuminated—not suddenly, but gradually—the *Pelomyxa* showed no effect.

* 'Arch. f. Phys.' (Pflüger), xix. (1879) p. 1; 'Nature,' xx. (1879) p. 106.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Permeability of Pellicle Precipitates.*—The well-known experiments of Traube on artificial cells have been repeated by Hugo de Vries, who comes to conclusions quite opposite to those of the German observer.

Starting with Traube's experiments upon the artificial cell or pellicle-precipitate produced by a copper salt in a solution of potassium ferrocyanide, De Vries says that if, as Traube maintains, the precipitated membrane is impermeable to its two membranogens (i. e. the copper salt and the ferrocyanide), the membrane will not undergo any increase in thickness; while if, on the other hand, the pellicle is permeable by the membranogens, it will continually increase in thickness until one of them is exhausted.

De Vries experimented upon a flaccid cell of copper ferrocyanide, obtained by introducing a drop of a 3 to 5 per cent. solution of cupric chloride, by means of a fine pipette, into the bottom of a tall vessel containing a 20 per cent. solution of potassium ferrocyanide. The blue drop became surrounded with a delicate, colourless, transparent pellicle, which for a half to one hour seemed to undergo no change. At the end of this time, however, brownish spots appeared on it, and increased in number and size until the whole cell-wall had a brown tint, which gradually darkened, until the whole pellicle was dark brown, opaque, and quite rigid and brittle. During the whole time —at the end of twenty-four hours, in fact—the cell had undergone no increase in size. If ruptured at this time, the rent was not closed up by the formation of a new pellicle, showing that all the copper salt had passed out of the cell; moreover, the colour of the contents of the latter was seen to be yellow—that is, to consist of the ferrocyanide.

Thus, the pellicle of cupric ferrocyanid is proved to increase in thickness, and must therefore be permeable to one or both of the membranogens. Several other experiments of similar nature were made, and all tended to prove the same thing—in all there was a progressive increase in the thickness of the pellicle, and a continual change in its physical properties.

The author concludes by remarking that, by these results, the supposed analogy between pellicle-precipitates and living protoplasm is shown to be only apparent, and devoid of all real significance.†

Origin of Chlorophyll-grains.—The view of Mohl, Sachs, Wiesner, and others, that grains of chlorophyll are formed directly from the starch and other carbohydrates which constitute the reserve food-

* 'Arch. Néerland.,' xiii. (1878) p. 344.

† This remark can hardly be said to apply to Traube's experiments with gelatin-tannate pellicles, although the fact of the copper-ferrocyanide pellicle growing by deposition of layers, and not, as Traube thought, by intussusception, renders a repetition of these experiments necessary. (See Sachs' 'Textbook of Botany,' p. 594.)

materials of plants, has been subjected to rigid investigation by Mikosch,* who has arrived at the following results:—

1. In all young organs which are filled with starch-grains, the chlorophyll-grains are formed by the investiture of the starch-grain with a green or yellow protoplasm. Within this envelope a gradual absorption of the starch goes on, followed, when the starch-grain is compound, by its breaking up into its derivative grains. Grains formed in this way he calls starch-chlorophyll-grains.

2. The starch-chlorophyll-grains are, as a rule, parietal; only in the leaf-stalks of the primordial leaves, and in the young axial organs, do they more often originate from a mass of protoplasm which surrounds the central nucleus.

3. The starch-chlorophyll-grains are functional when fully developed; they assimilate, and multiply by division. The only exception to this rule occurs in the case of the large grains found in the cotyledons of the pea, in which no vital activity was ever observed.

4. When no starch is present in the tissue in the form of grains, the chlorophyll-grains are formed in the way already described by Sachs, by the breaking up of the hyaline parietal layer of protoplasm into separate green portions, which eventually become yellow. These grains, formed directly out of the protoplasm, without a starch-grain taking any apparent share in the process, Mikosch calls protoplasm-chlorophyll-grains. The differentiation of the protoplasm goes on both in the light and in the dark; but is more rapid in the former case, and, within certain limits, the more rapid the greater the intensity of the light.

Heliotropism of Plants.—Professor Wiesner reprints from the 'Denkschriften der math.-naturw. Classe der kais. Akad. der Wissen.' of Vienna, vol. xxxix., the first part of an important monograph, 'Die heliotropischen Erscheinungen im Pflanzenreiche.'

After a copious historical sketch of previous investigations, he divides the subject as follows:—In the first chapter the influence of the intensity of light on heliotropism is investigated; and the author shows that a maximum effect is produced by a certain intensity, on each side of which there is a gradual decrease to zero. In the same manner he found an upper limit of light-intensity for growth in length, and also that the upper limit for heliotropism is above or below that for growth in length. Direct sunlight may completely arrest growth in length. In the second chapter he shows, in opposition to the received theory, that all rays of light, with the exception of yellow, even the dark and ultra-violet (red?) rays of heat, may produce heliotropism; in plants which are but little sensitive to heliotropism, the action of the colours of the spectrum decreases in proportion to their heliotropic power. The hypothesis that the heliotropic power of light is in proportion to its mechanical intensity or thermal power is altogether disproved. The third chapter is devoted to the investigation of the connection between heliotropism and geotropism; and in the

* 'SB. Akad. Wiss. Wien,' lxxviii. (1878) p. 265.

fourth it is proved that free oxygen is essential to heliotropism, and that all heliotropic curvatures are dependent on unequal growth. The fifth and last chapter treats of photo-mechanical induction in heliotropism; the important fact being here demonstrated that the inductive actions of light and gravitation do not cooperate, but are in opposition to one another, and that heliotropic induction is virtually mechanical.*

Symbiosis.†—Professor L. de Bary, in his address at the last Meeting of German Naturalists, proposed the term "symbiosis" as a general designation for parasitism and analogous phenomena ("mutualism," &c.) in the vegetable kingdom, for which the terms used in zoology are not always exact or appropriate. He distinguishes two principal divisions—"antagonistic symbiosis," in which there is a struggle; and "mutualistic symbiosis," in which the two organisms receive a reciprocal advantage.

Is the Ovule an Axial or a Foliar Structure?‡—The theory that the ovule is of the nature of a bud was powerfully upheld by the great morphologist, Von Mohl. Of recent years the opposite view, that it has more the character of a leaf or of a part of a leaf, advocated with great weight of argument by Celakovsky, and finally supported by Eichler, has met with favour from the majority of botanists. Great ingenuity has been displayed on both sides in adapting to each theory, facts which appear at the first sight plainly to contradict it, especially in the case of malformations, on which both parties greatly rely to prove their case.

Under the title "Ueber Placentarsprosse" Peyritsch supplies another contribution to the literature of the subject. He starts with the assertion that cases, in his opinion, unquestionably occur, of placental shoots or buds taking the place of ovules, with regard to which there is no reason for regarding them as adventitious shoots. This view he supports by the description of abnormal placental structures in *Reseda lutea*, *Sisymbrium Alliaria*, and other cases. He believes that neither of the two rival theories can be accepted as of universal application, but that a series of intermediate forms exists between the normal ovule and the nucleus-bearing segment of a leaf. Notwithstanding all that has been said to the contrary, the normal ovule has more the characters of a bud than of a leaf, and can best be compared to a minute bulb, while malformations often partake much more of a foliar character. He regards, therefore, the ovule as a structure adapted for sexual reproduction, of a variable morphological nature, and is not of opinion that abnormalities are of any great value in determining this last question. As an analogical structure he adduced the cyathium of the Euphorbiaceæ, intermediate between an inflorescence and a true flower, and regarded by the best authorities in different lights.

* See 'Bot. Zeit.,' xxxvii. (1879) p. 341.
† 'Rev. Internat. Sci.,' iii. (1879) p. 301.
‡ 'SB. Akad. Wiss. Wien,' lxxviii. (1878) p. 220.

Starch-transforming Ferments.* — Substances which possess the power of producing fermentation in starch, i.e. of transforming it into sugar, were found by Baranetzky in dormant and germinating seeds which contain starch, in germinating starchy tubers, in stems and leaves, and also in receptacles for reserve materials which contain no starch, as in germinating turnips and carrots. The result was the same whether the plants grew in the light or in dark. The product of the fermentation of starch was determined by quantitative analysis to consist of a mixture of glucose and maltose, the analysis being made as soon as the starch reaction with iodine failed. The formation of these sugars was hindered by elevation of the temperature. From the similarity of its action, Baranetzky concluded the identity of the ferment obtained from different plants. He believes, in accordance with Payen, that the chemical process which takes place is, that dextrin is first formed, and subsequently sugar by absorption of water; not as O'Sullivan thinks, a division of the molecule of starch into dextrin and sugar. The granulose in the starch-grains is first acted on, then the cellulose (farinose). The action takes place with very different rapidity in different starch-grains; those of wheat and buckwheat ferment speedily; those of rice and potato only with great difficulty; and this is not altogether dependent on the relative proportion of the two ingredients in the starch; since the grains of the scarlet-runner, which leave behind a tough skeleton of farinose, are acted upon very rapidly, those of the horse-chestnut only with great difficulty, although they leave but a very delicate skeleton. The actual ferment he believes to be an albuminoid, and its action to be dependent on the presence of oxygen. The distribution of this ferment in the vegetable kingdom he concludes to be very general.

Krauch differs from Baranetzky in maintaining diastase to be a definite chemical compound, which he has detected in onions and the seeds of the gourd. He agrees with that writer in regarding diastase as a widely distributed substance in organs which contain starch, and generally in proportion to the amount of starch. It sometimes exists in the organ while in a dormant state; sometimes it is only found when active growth begins.

Tannin in Vegetable Cells.† — J. B. Schützler records the results of some experiments on this subject. The test employed was the action on ferric chloride or some other iron salt, which causes the protoplasm to contract, kills it, and then produces a black precipitate when tannin or a substance belonging to the same series is present. This was first observed in the glands which cause the oily feel of the upper surface of the leaves of *Paulownia imperialis*, and subsequently in the leaves of *Prunus Laurocerasus*. Tannin was also found in fresh-water algæ belonging to the genera *Vaucheria*, *Spirogyra*, *Conferva*, &c., in sufficient quantities for a good ink to be prepared from the

* 'Die stärkeumbildenden Fermente in der Pflanzen,' von Dr. J. Baranetzky, Leipzig, 1878. 'Beiträge zur Kenntniss der ungeformten Fermente in der Pflanzen,' von K. Krauch, Erlangen, 1878. See 'Bot. Zeit.,' xxxvii. (1879) p. 156.

† 'Arch. Sci. Phys. et Nat.,' i. (1879) p. 344.

alcoholic solution of their chlorophyll. A marine alga, *Ulva Lactuca*, showed no precipitate of tannin when treated in the same way; and the same was the case with a moss, *Hypnum triquetrum*, examined in the month of March.

Functions of Vessels.*—In a somewhat elaborate article on this subject, J. Böhm gives two reasons for arriving at conclusions in some respects at variance with the views hitherto entertained.

The dictum dogmatically asserted by Schleiden, that the mature vessels, and especially the spiral vessels, never contain water, but only air—an assertion made on his authority by most subsequent writers—Böhm maintains, from the result of a series of observations, to be incorrect. The original fluid contents of the cambial vessels are in most plants partially, in others completely absorbed by the sap-conducting cells, without any corresponding volume of air being given off. When the vessels have become older, they are filled from the adjoining cells either more or less completely with sap or with air of ordinary tension. In those vessels whose gaseous or fluid contents are subject to less than the ordinary atmospheric pressure, drops of gum or protoplasm are given off from the adjoining cells through the bordered pits, the latter being enveloped in cellulose, and developing into the so-called "Tüllen" or "thyllæ." Air-dried branches in which the vessels do not possess thyllæ absorb only a small quantity of water. Branches cut off and placed immediately in water in the summer increase considerably in weight, but if laid for any time in dry or damp air before being placed in water, they absorb only so much water as they lose by evaporation. In the first case the vessels immediately absorb water; in the latter case their open ends become filled with air, and hence less easily permeable to water.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Embryology of Vascular Cryptogams.†—Leitgeb contributes a paper on this subject to the 'Proceedings of the Vienna Academy of Sciences,' relating chiefly to the Rhizocarpeæ. The following are the principal results arrived at:—

1. The position of the first partition-wall in the embryo of *Marsilea* is a definite one, and independent of that of the macrospore and prothallium, inasmuch as it in all cases includes more or less exactly the axis of the archegonium; but it is movable round the latter, and, as soon as the axis of the archegonium deviates from the vertical, assumes such a position that the embryo is divided into two superposed halves.

2. The embryos of *Marsilea* and *Salvinia* resemble in their development those of the Polypodiaceæ until the formation of the octants. The organs are developed after the formation of the octants; up to this time the embryos are thallomes.

3. The "pedicel" of *Salvinia* is developed from that half of the

* 'Bot. Zeit.,' xxxvii. (1879) pp. 225, 241.
† 'SB. Akad. Wiss. Wien,' lxxvii. (1878) p. 222.

embryo from which the stem is formed; the posterior half of the embryo (the "hypobasal" half, from which in *Marsilea* and Polypodiaceæ the root is formed) appears in *Salvinia* only as a swelling or "bulb" at the base of the pedicel.

4. The "pedicel" of *Salvinia* corresponds therefore, in its origin and development, to the pedicel of the sporogonium in Hepaticæ.

5. The embryo of *Salvinia* bears a closer resemblance than that of any other vascular cryptogams to the embryo of Hepaticæ, since in the latter the "bulb" and "pedicel" are similar in origin and development; the ultimate difference depends on the "apical octants," which in the Hepaticæ enter partially or entirely into the formation of the sporogonium, while in *Salvinia* they take part in the formation of the "peltate leaf" and the stem.

Adventitious Buds in Ferns.*—Accepting Mettenius's definition of adventitious buds as "those which arise, equally independently of the base of the leaf with those which result from dichotomy, in the form of a new formation beneath the growing-point of the main axis," the lateral buds described under this category by Hofmeister in *Pteris aquilina*, *Aspidium filix-mas*, *Asplenium filix-femina*, *Struthiopteris germanica*, and *Asplenium Belangeri*, must, with the exception of those of the last-named species, be excluded from it. To the list of ferns producing true adventitious buds on the lamina of the frond Heinricher now adds *Diplazium celtidifolium*, *Asplenium bulbiferum*, and *A. viviparum*. The following is an epitome of the results of his observations:—

1. The adventitious buds of ferns are united to the parent organ by the course of the vascular bundles.
2. The position of the buds varies; but is constant in the same species within certain limits.
3. In all the cases examined, in their later stages, at all events as soon as a frond is formed, the buds grow by an apical cell which becomes segmented triangularly.
4. In earlier moderately advanced stages, but before the formation of a frond, an apical cell is scarcely ever to be recognized.
5. But in the youngest stages observed, an apical cell with triangular segmentation could be detected.
6. The origin of all the buds is exogenous, and the series of their stages of development points to an acropetal succession.
7. The buds may proceed from a single superficial cell, in which a triangular apical cell is formed.
8. The origin of the buds is at a very early period. The separation of the parent-cells of the adventitious buds can apparently not take place too far from the apex of the frond or of the pinna.

Production of the first vegetative Shoot of Equisetum palustre.†—From the prothallium of *Equisetum arvense*, *palustre*, *variegatum* and probably other species, is produced first of all a vegetative shoot, which soon perishes, distinguished from the permanent ones by the

* 'SB. Akad. Wiss. Wien,' lxxviii. (1878) p. 249.
† 'Bot. Zeit.,' xxxvii. (1879) p. 289.

leaf-sheaths having only three teeth. A. Tomaschek has succeeded in keeping these first shoots alive for a space of two years. The cells of these shoots possess an active power of vegetative reproduction, and the writer believes that, in favourable circumstances, sporangia may arise on them. The secondary stems produced from them have also leaf-sheaths with only three teeth.

Muscineæ.

Origin of Tubes in the Nostoc-colonies in Blasia.*—The formation of colonies of Nostoc in the thallus of *Blasia*, especially in its thalloid appendages or "auricles," has been fully described by Janczewski, Leitgeb, and others. They have also spoken of the production of long tubes penetrating these colonies, a phenomenon which has received further elucidation from M. Waldner. The following are the main results arrived at:—

1. The formation of tubes in the auricle of *Blasia*, when infected by Nostoc, proceeds from the papilla (trichome) which projects into the cavity of the auricle; this papilla consisting of a bluntly conical basal cell and a capitate terminal cell.

2. The tubes developed from this papilla, in consequence of the infection by Nostoc, are not constituted of a single cell.

3. In most cases the tube is developed from the basal cell, while the terminal cell remains unchanged and then dies off, or less often also developes into a tube.

4. The formation of the tube commences by the upper margin of the basal cell swelling out on one side into the form of a cushion, or putting out protuberances on all sides, which become separated by septa from the parent-cell, grow at their apex, and branch, the lateral branches also becoming separated by septa.

5. No regularity can be observed in the development of the tubes. The numerous modifications in their origin, number, and branching, are dependent on the development of the Nostoc.

Fungi.

Endophytic Fungi in Pollen-grains.†—A. Tomaschek has investigated the occurrence of parasitic fungi within pollen-grains, especially in the largest or "antheridial" cell of the multicellular grains of some Coniferæ.

Among the pollen of *Pinus sylvestris* were found cells from which zoospores were occasionally seen to escape, and which were identified by Cohn as being closely allied to the *Chytridium pollinis pini* of A. Braun. The writer, however, prefers to establish it as a distinct genus under the name *Diplochytrium*, distinguished from *Chytridium* by possessing a double cell-wall, and also by not being actually endophytic within the pollen-cells. The organism may, however, be simply the resting-stage of a *Chytridium*. The *Chytridium pollinis pini* is readily detected within the largest pollen-

* 'SB. Akad. Wiss. Wien,' lxxviii. (1878) p. 294. † Ibid., p. 197.

cells of *Pinus americana*, as many as twenty or thirty of the parasites being found in a single grain. The escape of zoospores from these may occasionally be observed. *Chytridia* were also observed in the pollen-grains of *Typha latifolia*, *Lilium lancifolium*, and *Cannabis sativa*. *Chytridium luxurians*, also endophytic in the pollen of *Pinus sylvestris*, is distinguished by the fact that it never leaves the pollen-grain, but, when mature, emits a tube which projects outside the pollen-grain, through which the zoospores are ejected. The development of these truly endophytic fungi is often obscured by the growth of other fungi among the pollen-grains, the germs of which have been floating in the air, &c.; especially of *Apisporium pinophilum* Fuckel, which first appears as a torula, and then develops dark brown, club-shaped perithecia.

Rate of Germination of Fungus-spores and Growth of Mycelium.*—Dr. G. Winter has made a series of experiments on this subject, extending over a considerable number of species belonging to several different orders of fungi.

The germination of the spores he found to be dependent on a variety of circumstances, such as sufficient access of oxygen and a sufficient supply of moisture, some germinating in moist air, others only when swimming on or actually submerged in water. In some species the development of the germinating filaments takes place at the expense of the food-materials stored up in the spore; others require an external supply. For the germination of most fungus-spores a temperature of from 12 to 20° C. is necessary. Of a large number of fungus-spores which were subjected to experiment, the most rapid germination was exhibited by *Nectria cinnabarina*, viz. in 2½ hours; the least rapid by *Actrostalagmus cinnabarinus*, viz. in 65½ hours. The slowest development of the germinating filament was manifested by *Mucor Mucedo*, viz. at the rate of 2·5 mmm. (micro-millimetres) per minute in a nutritive fluid, ⅔ mmm. per minute in water; the most rapid by *Pilobolus crystallinus*, viz. at the rate of 36 mmm. per minute.

New parasitic Phycomycete.†—In the 'Sitzungsberichte des bot. Vereins der Prov. Brandenburg' W. Zopf describes a new fungus allied to the Saprolegnieæ, which is parasitic on *Spirogyra* and other filamentous Conjugatæ, and which he names *Lagenidium Rabenhorstii*. The biciliated swarmspores attach themselves to a cell of the host, invest themselves with a cell-wall, perforate the wall of the infected cell by means of a filament, and develop into a unicellular mycelium. The hyphæ afterwards become septated, and each cell is a zoosporangium, containing from two to thirteen zoospores. The sexual plants are produced from zoospores which penetrate a cell of the host in pairs, one giving rise to a male, the other to a female plant. The male plant becomes divided into a number of cells, all but one of which produce zoospores, the other becoming an antheridium; it does not give birth to antherozoids, but pierces the female cell, into

* 'Hedwigia,' xviii. (1879) p. 49.
† See 'Bot. Zeit.,' xxxvii. (1879) p. 351.

which its protoplasmic contents pass. The female cell resembles a sporangium, but has no perforating filament. After fertilization the oosphere develops into a yellowish brown double-walled oospore, the epispore of which is covered with elegant spines.

The "Carolo vero" and "Carolo bianco" of the Rice.*—The cause of these two diseases to which rice is subject is described by Professor Garovaglio in a pamphlet entitled 'Del Brusone o Carolo del Riso.' It is a fungus belonging to the genus *Pleospora*, to which he gives the name *P. Oryzæ*, and of which he describes the spermogonia, perithecia, and pycnidia. In the "carolo bianco" the parasite has attained only an earlier stage of its development; in the "carolo vero" it has reached a more perfect stage. Its presence is shown by the dry, dull-red leaves and leaf-sheaths, the blackish, often torn nodes, which have sometimes altogether disappeared, and the dark, smutty spike which falls out on the least touch. The grain is empty, both embryo and endosperm having completely disappeared. The fructification makes its appearance over the whole plant.

Sporormia, a Subgenus of Sphæria.†—R. Pirotta proposes to re-establish, with some modifications, De Notaris's genus *Sporormia*, nearly synonymous with the *Hormospora* of the same author, usually sunk in the enormous genus *Sphæria*.

The following is his diagnosis of the genus:—Stroma none or simple; perithecia scattered or gregarious, half-immersed or superficial, never enclosed, smooth, globose or oblong-conical, black, sometimes transparent, papillose, prolonged into a mamillæform or irregular conical neck; asci cylindrical, subclavate or widest in the middle, containing usually eight ascospores, prolonged into a pedicel, rarely sessile; paraphyses, when present, filiform, undivided or septate, simple or branched, numerous, flaccid, gelatinous; ascospores cylindrical, composed of from four to twenty jointed or moniliform sporidioles, dusky or nearly black, sometimes encircled by a hyaline gelatinous ring; when mature breaking up into the separate sporidioles. The description of the genus is followed by that of twenty species.

Sclerotium Oryzæ.‡—This form of "sclerotium" is described by Cattaneo as appearing in enormous quantities on the lower portions of the haulm of the rice beneath the water, to which it is excessively destructive, appearing especially in the hollow of the stem, and in the leaf-sheaths. It is globular and very small, with brownish membrane and yellowish protoplasm. The writer states that cavities are developed within the sclerotium, which increase and finally coalesce; and that spores are then formed by abstriction from the ends of hyphæ which appear within the cavities. Their germination was not

* See 'Bot. Zeit.,' xxxvii. (1879) p. 359.
† 'Nuov. Giorn. Bot. It.,' x. (1878) p. 127.
‡ 'Archivio triennale del laboratorio di Botanica Crittogamica di Pavia,' vol. ii.; see 'Bot. Zeit.,' xxxvii. (1879) p. 327.

followed out. The disease thus caused has only recently made its appearance.

Structure of Depazeaceæ.—Under this head M. Crié includes* a section of Pyrenomycetes comprising the genera *Diplodia*, *Septoria*, *Glœosporium*, *Sphæropsis*, *Hendersonia*, *Phyllosticta*, *Pestalozzia*, *Morthiera*, *Depazea*, and their allies, all of very minute size, which cause the coloured spots on the leaves of many trees that contribute so much to the autumn tints of foliage. The fungi described as *Xyloma* and *Ectostroma*, generally regarded as distinct organisms, but treated by De Bary as merely pathological products of the leaves, M. Crié considers to be stages in the development of other Depazeaceæ. The Depazeaceæ are distinguished from other foliicolous Sphæriaceæ by the thalloid spots which serve as a support to the reproductive organs. Their first appearance is in the form of a simple black dot, in which state they form the genus *Ectostroma*. The reproductive organs are spermogonia with their spermatia, pycnidia with their stylospores, and perithecia with their asci and ascospores; these do not present anything especially different in their structure from that of other Sphæriaceæ. The spermatia of *Depazea*, Crié considers, along with Berkeley and Cooke, to be not sexual organs of reproduction, but a kind of non-sexual spore less perfectly developed than the stylospores or ascospores. He finds that they germinate only with difficulty, and never produce a mycelium comparable to that which proceeds from the other kinds of spores. The stylospores he found to germinate, after they had been preserved in a herbarium for half a century, just as if they were fresh gathered.

Two New Vine-Parasites.—In the 'Archivio triennale del Lavoratorio di Botanica Crittogamica di Pavia,'† Dr. Cattaneo describes two new fungus-parasites on the vine which have made their appearance in North Italy, *Sphærella fumaginia* and *Phoma baccæ*, the latter closely allied to the *P. uvicola* which is so destructive to the vine in America. The nearly ripe berries shrivel up and become more or less strongly coated with a sweetish granular substance soluble in water. The black conceptacles are formed inside the berry, and finally burst the skin; the spores are yellowish and unicellular.

Conjugation of Swarmspores of Chroolepus.—Although this phenomenon had not been observed during the careful investigation of this alga by Frank, Wille claims to have detected it‡ in a few instances in *Trentepohlia umbrina* (*Chroolepus umbrinum*) growing on the horse-chestnut. Of a very large number of swarmspores observed, the immense majority disappeared without conjugating or becoming invested with cellulose. In a very few instances conjugation was detected, the swarmspores thus proving to be planogametes, in De Bary and Strasburger's use of the term. In only one or two instances was the subsequent investment with cellulose detected. The question needs further investigation.

* 'Ann. des Sci. Nat. (Bot.),' vii. (1878) p. 5.
† See 'Bot. Zeit.,' xxxvii. (1879) p. 358.
‡ 'Botaniska Notiser,' 1878, p. 165; see 'Bot. Zeit.,' xxxvii. (1879) p. 294.

Formation of Conidia by a Bacillus.*—M. Engel draws attention to the discovery of the fact that certain *Bacilli* taken from a woman during childbirth produced, when placed in Pasteur's solution, conidia; he points out that this observation was published before the paper of Koch on the same subject, and he states that he has applied to the *Bacillus* in question the specific name of *puerperalis*. The body from which the blood containing the *Bacillus* was taken had a peculiar odour; and the blood when injected into a rabbit produced death in thirty-six hours, whereas the conidia had no poisonous effect. The author further draws attention to what he believes to be an error in the statement† that a species of *Leptothrix* had produced illness, and is of opinion that the form, if immobile, is probably one of the *Bacteridia*, and, if mobile, is in all likelihood the *Bacillus* discovered by M. Spillmann, and examined and described by himself.

Fermentation of Cellulose.‡—As long ago as 1850, Mitscherlich announced the fact that cellulose can be made to ferment; and in 1865, Trécul found that this fermentation is due to minute amylaceous particles to which he gave the name *Amylobacter*. Van Tieghem has now determined that the various forms of this body which Trécul described, are different states of the same bacterium belonging to the genus Bacillus, to which he gives the name *Bacillus Amylobacter*.

This bacterium attacks the cell-wall, which it finally destroys, without in any way affecting the cell-contents, whether albuminoid or amylaceous. It does not however attack all cell-walls indifferently, except in the case of the embryo. Those tissues have the greatest powers of resisting its attacks which are cuticularized, suberized, lignified, or encrusted with mineral substances. Gelatinous tissues are especially liable to be disintegrated by it. In aquatic plants the cellulose, even of the stem and leaves, has a remarkable power of resisting the attacks of this agent. The spores of *Amylobacter*, like those of other bacteria, have the power of resisting without injury a lengthened exposure to a temperature of 100° C., or that of boiling water. The first effect of *Amylobacter* is to transform cellulose or soluble starch (it has no effect on insoluble starch) first into dextrin and then into glucose, with elimination of carbonic acid, and production of an acid the exact composition of which is not yet determined. The action of the *Amylobacter* on cellulose appears to be direct, without the intervention of a diastase.

Resistance of Germs to a Temperature of 100° C.§—M. Ch. Chamberland has already shown the existence of a microscopic organism (*Bacillus subtilis?* of Cohn) having the following properties:—

1st. It is exclusively aerobian, and does not develop at all in a perfect vacuum or in pure carbonic acid.

2nd. It grows in almost all organic liquids (infusions of yeast, hay, carrots, &c.), provided they are previously neutralized by potash. There is no development in acid liquids.

3rd. It gives rise to germs or spores which, in neutral media, resist

* 'Comptes Rendus,' lxxxviii. (1879) p. 976.
† See this Journal, ii. (1879) p. 454.
‡ 'Comptes Rendus,' lxxxviii. (1879), p. 205.
§ Ibid., p. 659.

for many hours a temperature of 100° C. In infusions of yeast or hay they may resist for five hours, whilst in distilled water they are killed by two or three hours' boiling. A temperature of 115° kills them very rapidly.

4th. When boiled for a few minutes in a slightly acid medium these spores are not killed, for they develop when the liquids are placed in sterile neutral media.

5th. A temperature of 40° seems most favourable to the growth of these organisms, though they still develop at 50°.

Whilst pursuing these researches he encountered another organism, also a *Bacillus*, which is both aerobian and anaerobian. When in air it absorbs oxygen from it, but in vacuo it acts as a ferment, and disengages a mixture of carbonic acid and hydrogen; thus resembling the yeast of beer.

It develops also in neutral or slightly alkaline media, and not at all in very acid liquids.

Its germs or spores resist a temperature of 100°, but for a much shorter time than the spores of *Bacillus subtilis*. In distilled water at 100° they resist for thirty minutes, but are killed in forty minutes.

Like *Bacillus subtilis*, the spores are not killed when sown in slightly acid liquids and boiled for some minutes.

The temperature most favourable to their development is that which suits *Bacillus subtilis*.

The liquids in which the new *Bacillus* multiplies become distinctly acid, whereas *Bacillus subtilis* produces no change.

These results lead to important conclusions.

1st. The boiling of water in an apparatus for some minutes, and even for more than an hour, may not be sufficient to deprive it of all living germs, since the germs of the organisms here referred to are found in ordinary water, although in variable proportions.

2nd. In manipulating neutral or slightly alkaline organic liquids the apparatus used must have been previously subjected to a very high temperature.

It is doubtless because apparatus was made use of which it was believed was freed from germs merely by the boiling of the water, that natural milk fresh from the cow's udder could not hitherto be preserved.

By the use of the above apparatus, however, M. Chamberland proved two years ago that such milk will keep indefinitely, without producing organisms, in contact with pure air.

Many experiments claimed as favouring the spontaneous generation theory are therefore explained in a very simple and rational way.

Lichens.

Observations on Microgonidia.*—The Rev. J. M. Crombie, writing on the investigations of Dr. Minks and Dr. Müller † on what the former calls *microgonidia* (or the minute corpuscules which, according to him and Dr. Müller, are in their evolution changed into gonidia, and constitute the initial state of the latter), says that he does not

* 'Grevillea,' vii. (1879) p. 143. † See this Journal, ii. (1879) p. 311.

hesitate to affirm that every competent observer will entirely coincide in the view of Dr. Nylander, who declares that the "*microgonidia*" are no new discovery whatever, have nothing at all in common with gonidia, and in fact are simply what is called in vegetable anatomy "molecular granulations," which never, if present in the cellules, go forth from them, and never present any cellular metamorphosis; that so far from their being any novelty, their existence has been well known to every microscopic observer, and that vainly in these granulations shall we seek for anything having any special relation to gonidia or their origin.

Mr. Crombie considers therefore that "the labours of Dr. Minks" cannot in any way, in so far at least as his discovery of "microgonidia" is concerned, be regarded as "profoundly modifying the anatomical notions which were entertained concerning the thallus of lichens." Rather is it to be regretted, in the interest of true science, and for the final suppression of Schwendenerian opinions, that these labours, valuable in some respects as they may be, should have resulted in the promulgation of another theory as untenable as that which Dr. Minks set himself to destroy.

In regard to the "zoospores or zoosporoid corpuscles," which Dr. Müller mentions as having been observed by him in certain gonidia, "contento contracto," gyrosely agitated (and also in the spores of *Agaricus rimosus*), Mr. Crombie considers this a discovery of exactly the same nature as that of *microgonidia*, and that they are in reality nothing more than the same "molecular granulations." The motion which he saw is evidently the well-known Brownian movement, an ordinary property of molecular granulations to agitate themselves where sufficient space is allowed them.

Leighton's 'Lichen-Flora.'—The third edition of the 'Lichen-Flora of Great Britain, Ireland, and the Channel Islands,' has been issued, and is the consequence of the extensive discoveries of Mr. Larbalestier in the west of Ireland, and the inferior, but very interesting, ones of Mr. Crombie, Dr. Stirton, and others, in the north of Scotland, and the author's own extensive researches in North and South Wales, whereby our lichen-flora has been raised to an equality in numbers, rarity, and novelty with that of any other country in Europe.

The number of species and varieties or forms comprised in the second edition of the work amounted to 1156, whilst in this third edition they have risen to 1710. The work is preceded by an introduction to the study of lichens, with their geographical distribution, general and local, and their uses. The descriptions have been revised and corrected throughout, and measurements of the spores from the works of Mudd, Nylander, T. M. Fries, and the author's own, have been added. A copious glossary, list of authors and exsiccati quoted, and an exhaustive index have been appended.

Microscopical Slides of Lichens.—Messrs. Holmes and Joshua's first fasciculus of a series of microscopical slides of British lichens, announced some time since,* has now been issued. The fasciculus

* See this Journal, i. (1878) p. 379.

contains 48 slides, very neatly mounted and secured in a suitable box. These slides are intended to illustrate groups of lichens, and to be of use also in teaching amateurs and beginners the outlines of lichenology by making the appearance of the different parts of lichens familiar to the eye. Special care has been taken to exhibit the final organs of reproduction—the spores—of much use in determining the systematic position of lichens; and we may venture to suggest that a similar attention to the earlier stages of the reproductive organs and the thallus would improve future fasciculi. A considerable number of the specimens are rare, or recently discovered in Britain, and from this point of view will be interesting to the expert lichenologist Such a series as this must be of more use to the microscopist for the purposes of reference than the illustrations of any lichenological work we know of. We have had the opportunity of examining, at the British Museum, a parallel series of slides of Algæ and Hepaticæ.

Algæ.

Structure and Mode of Reproduction of Cutleriaceæ.*—The history of development of the Cutleriaceæ has been carefully followed out by Reinke in the cases of *Cutleria multifida*, *Zanardinia collaris*, and *Aglaozonia reptans*.

As regards the vegetative development, he finds that the margin of the thallus becomes dissociated into a number of threads, which he calls "cilia," a term obviously open to objection. At the basal part of these threads is a meristem; and here the threads coalesce into a solid thallus. The increase in breadth of the frond is due to branching of these threads. The reproductive organs of *Cutleria*, Reinke terms antheridia and oogonia. The former, arranged in groups on the thallus, are septated chambers placed on a multicellular pedicel. The antherozoids are formed in pairs in a cell. The oogonia, which occur on separate plants, are far less numerous. They resemble the antheridia in form and arrangement, but are considerably larger. From them are developed sixteen or thirty-two oospheres, which escape in the form of biciliated swarmspores, to which the antherozoids attach themselves and disappear, probably becoming absorbed in the substance of the swarmspores. These lose their cilia and secrete a cellulose envelope; their further development has scarcely been traced. Thuret found the swarmspores germinate without assistance from the antherozoids. The development of the thallus of *Zanardinia* agrees with that of *Cutleria*. In addition to the sexual organs Reinke found "neutral spores" formed in unicellular sporangia, which break up into four or six pear-shaped swarmspores. The antherozoids force their way into the oosphere, which then germinates. In *Aglaozonia* no sexual organs were found, but non-sexual sporangia similar to those of *Zanardinia*.

These observations, and those of Göbel on *Ectocarpus* † seem to

* 'Nova Acta Leop.-Carol. Akad. Naturf.,' xl. p. 37; see 'Bot. Zeit.,' xxxvii. (1879) p. 142.

† 'Bot. Zeit.,' 1878, Nos. 12, 13.

indicate that the Phæosporeæ form a connecting link between the Zygosporeæ and the Oosporeæ.

New Parasitic Alga.*—J. Kühn has made the interesting discovery of an alga parasitic on the leaves of *Arisarum vulgare* (*Arum Arisarum*) in the neighbourhood of Mentone and Nice.

On otherwise normally developed leaves, specks were observed of a roundish form, usually 10 or 12 millimetres in diameter, having all the appearance of a parasitic fungus. Closer examination showed, however, that the parasite consists of filaments always densely filled with chlorophyll-grains; in fact, that it is an alga nearly allied to *Vaucheria*, and propagating in the same way, by the whole contents of the cell breaking up into microgonidia, which remain for a considerable period in a dormant condition. The author proposes for it the name *Phyllosiphon Arisari*. He considers the discovery to be of considerable interest from a systematic point of view, in forming a connecting link between the two sections of Sachs's subclass Cœloblastæ, those containing chlorophyll, viz. the Siphoneæ, and those destitute of chlorophyll, the Saprolegnieæ and Peronosporeæ. It is a very interesting addition to the small number at present known of truly parasitic algæ.

Siphonocladaceæ, a new Group of Green Algæ.†—In a descriptive article of the green algæ of the Gulf of Athens, T. Schmitz describes a new species and genus under the name *Siphonocladus Wilbergi*, which he proposes as the type of a new group, the *Siphonocladaceæ*, to include a number of genera of hitherto uncertain affinity, viz. *Chætomorpha*, *Cladophora*, *Pithophora*, *Microdictyon*, *Anadyomene*, *Valonia*, *Botrydium*, and *Struvea*.

The characters of the proposed group are to be found in the structure of the thallus, but still more in that of the protoplasmic cell-contents. The parietal primordial utricle is sometimes, though not always, furnished with a number of reticulate and anastomosing strings which run across the cell-cavity; imbedded in this are a number of small, flat chlorophyll-grains of irregular angular form and very variable size, which multiply by bipartition. The parietal protoplasm invariably contains a number of nuclei, scarcely distinguishable by their refractive power, but only by the application of reagents. The vitality of the protoplasm shows a remarkable power of resistance to external influences. As the mode of reproduction is not at present known in all the genera, and presents a variety of differences where it is known, it is probable that the group may hereafter be broken up into several subdivisions. In *Cladophora* and *Botrydium* non-sexual macrozoospores and sexual microzoospores are described; in *Chætomorpha*, *Anadyomene*, *Valonia*, and *Siphonocladus*, only zoospores of one kind; in *Microdictyon* and *Pithophora* no organs of the kind have yet been detected. The bodies described by Wittrock in the last genus as "spores," Schmitz believes to be gemmæ of peculiar form.

* 'SB. Nat. Gesell. Halle,' 1878; see 'Bot. Zeit.,' xxxvii. (1879) p. 322.
† Ibid., Nov. 30, 1878; see 'Bot. Zeit.,' xxxvii. (1879) p. 167.

Resting Condition of Vaucheria geminata.*—It has long been known that the unicellular vegetative thallus of various species of *Vaucheria* is liable to segmentation as the result of injury, the attacks of parasites, &c. In addition to this, in certain circumstances they are capable of undergoing a change, visible to the naked eye by the brighter green colour by which it is accompanied, in which the filaments become divided into a large number of cells of nearly equal size by thick gelatinous septa. In this state they form the genus *Gongrosira* of systematic works.

E. Stahl has made a special study of this condition of *Vaucheria geminata*. The *Gongrosira* is multiplied by the production of filaments from the various cells. A not unfrequent phenomenon is also the escape of the entire contents of one of the cells surrounded with cellulose, which thereupon proceeds to germinate. But more common is the breaking up of the protoplasm of a cell into a variable number of portions, at first, as they escape from the mother-cell, enclosed in a thin membrane, which subsequently swells up and bursts. The separate portions of the protoplasm then move about with an amœboid motion, slowly creeping over the substratum. The motion ultimately ceases, the protoplasm assumes a spherical form, and clothes itself with a thin membrane. All these changes may take place, and the resting-cyst be formed, even within the mother-cell. These cysts sometimes develop immediately into new filaments, but more often they remain for a time in a resting condition, in which they entirely lose their green colour. Their germination is marked by the reappearance of chlorophyll.

This condition of *Vaucheria* bears a striking resemblance to one of the forms of another of the Siphoneæ, *Botrydium*, described by Rostafinski and Boronin.

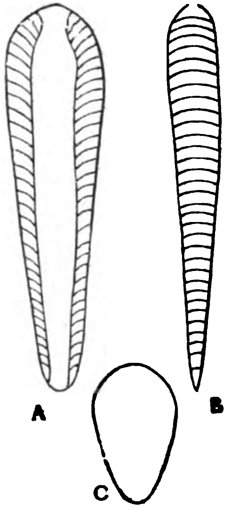
Italian Algæ.—The first volume (1878) of the 'Atti della Società Crittogamologica Italiana' is chiefly occupied by Ardissone's study of the Italian Algæ belonging to the family Rhodomelaceæ, which comprises the genera *Chondriopsis*, *Acanthophora*, *Alsidium*, *Digenea*, *Polysiphonia*, *Rytiphlœa*, *Vidalia*, *Dasya*, and *Hanovia*. Of *Polysiphonia* alone there are forty-eight species. The volume includes besides a description of a new form of *Melosira Borrerii*, by F. Castracane; an enumeration of the diatoms collected at Ostia, by M. Lanzi (a little over 100 species, no novelties); and a diagnosis of the genera belonging to the family Hypocreaceæ of Pyrenomycetes, by P. A. Saccardo, several of them new.

Subalpine Desmidieæ.—The last part of the 'Mem. della real. Accad. delle Scienze di Torino,' vol. xxx. 2nd ser., is occupied by the continuation of J. B. Delponte's 'Specimen Desmidiacearum subalpinarum,' the first part of which was published in 1876. It is intended to be supplemented by additions to our knowledge of the subject which have come to hand since the publication of the first part. The present part is illustrated with fifteen plates, and the whole will form a magnificent monograph of the subalpine Desmi-

* 'Bot. Zeit.,' xxxvii. (1879) p. 129.

dieæ, and will include the description of a very large number of new species.

Algæ from Lake Nyassa.*—Dr. G. Dickie describes in a paper to the Linnean Society some Algæ collected by Dr. Laws, of the Livingstonia Mission, Lake Nyassa, East Africa, all the genera of which are well-known European, &c., forms.



Epithemia clavata.
A, frontal; B, lateral view; C, small frustule in outline; all "greatly magnified."

Of the Diatomaceæ thirty-two species are enumerated, nearly all of which are also very widely diffused elsewhere; the exceptions are few, *Diadesmis* for instance, hitherto confined to the West Indies.

The only peculiar form is *Epithemia clavata*, n. sp.:—"Mediocris, plus minusve clavata, apicibus rotundato-obtusis, costis validis subparallelis, 15 in ·001; latere superiore (dorso) convexo, inferiore subrecto. Long. = ·001 — ·007 poll." It was more or less plentiful on aquatic Phænogams, but especially on *Spirogyra*. The clavate form at once distinguishes it from any known species; at first sight it has a resemblance to *Surirella* (see figures). The striæ proper are not represented here; they are 30 in ·001.

Thallus of the Diatomaceæ.†—Mr. J. Deby differs from the observations of Dr. Lanzi on this subject referred to in a paper by Mr. Kitton, which will be found on p. 38. What Dr. Lanzi describes as the "thallus," and as forming part of the living matter of the diatom is, Mr. Deby points out, nothing beyond what has been hitherto a matter of common observation, no species during a part at least of its existence being without a thin protecting envelope resting directly on the external surface of the siliceous envelope, and often so hyaline that to see it it is necessary to employ chemical reagents. The "thallus" is, in fact, nothing but an exudation, a special secretion.

He also considers that the "spores" which Dr. Lanzi found enveloped in the thallus are either granules of endochrome, drops of oil, &c., or unicellular algæ common in all stagnant waters, and which are often met with enveloped in a mucous mass similar to that described by Dr. Lanzi.

Mr. Deby still further doubts the assertion of Dr. Lanzi as to his having found a diatom in all its intermediate states from small spores up to frustules arrived at complete maturity, and asks for additional proofs of such assertions; the proper proof he considers would be to follow step by step, without discontinuing the observation, the exist-

* 'Journ. Linn. Soc. (Bot.),' xvii. (1879) p. 281.
† 'Brebissonia,' i. (1879) p. 113.

ence of an *isolated individual* from the moment of its birth to its complete transformation and maturity.

In a subsequent paper * Dr. Lanzi replies to M. Petit's criticisms and reaffirms his belief in the correctness of his previous observations.

Systematic Position of the Volvocineæ.†—M. E. Maupas criticizes in a recent number of the 'Comptes Rendus' the view put forward by Stein (in his 'Flagellate Infusoria'), that the Volvocineæ are Infusoria, thus returning to Ehrenberg's opinion and reopening the old discussions which after the researches of Cohn might be supposed to have been closed for ever.

According to Stein the true criterion which distinguishes a Protozoon from a Protophyte is the presence of vibratile flagella, contractile vacuoles, and a nucleus combined in one organism. The Protozoa alone combine these three, and it is upon this view that he excludes the Volvocineæ from the vegetable kingdom, and places them among the Flagellate Infusoria.

M. Maupas considers Stein's criteria to be without value, the three characteristics being found in algæ, whose vegetable nature Stein would not venture to dispute.

Everyone knows that all zoospores are provided with *vibratile cilia*.

As to the *contractile vacuole* it is astonishing that such an exact and generally well-informed observer as Stein should still deny the existence of this organ in the vegetable kingdom. It has been seen by Leitgeb, De Bary, Fresenius, Strasburger, Dodel-Port, and Cienkowski, in the zoospores of the Saprolegnieæ, Myxomycetes, *Ulothrix*, &c., and the writer himself has observed it in *Microspora floccosa* and *Stigeoclonium tenue*, and is satisfied that it would be found in many other zoospores if the research was made with sufficiently high powers and in good conditions of observation; at any rate the numerous facts already established are sufficient to disprove Stein's assertion.

With regard to the *nucleus*, Stein in denying its existence in the zoospores of algæ is no doubt in accord with most authorities. All observers who since Thuret have studied these organisms have failed to discover a nucleus, and Strasburger very recently ‡ allows that the nucleus of the zoospores of *Ulothrix* does not exist during its free life and is reconstituted at the moment of germination. M. Maupas, however, by using methods of observation which he has long employed for the study of the nucleus and nucleolus of the Infusoria, has succeeded in discovering a very clearly defined nucleus in the zoospores of *Microspora floccosa*, and of an *Œdogonium*.

He places a small drop charged with zoospores of *Microspora* on a piece of glass, covering it with the cover-glass and sucking out water so that the zoospores should be somewhat compressed and rendered nearly immovable; he then cements with paraffin two of the opposite margins of the cover-glass and draws under it a drop of

* 'Brebissonia,' i. (1879) p. 129.
† 'Comptes Rendus,' lxxxviii. (1879) p. 1274.
‡ 'Bot. Zeit.,' April 25, 1879, p. 274.

alcohol by sucking out the water with blotting-paper, by which means the zoospores are killed suddenly. The alcohol is then replaced by water, and that by saturated carmine. At the end of some minutes the latter is sucked out by blotting-paper, and replaced by water, and that finally by crystallized acetic acid which instantaneously clarifies the objects. There can then be seen in the rostral region of the zoospores a small spherical nucleus coloured an intense red and very clearly defined, the rest of the body remaining very pale. As acetic acid is very volatile, it is only necessary to place at the side of the cover-glass a drop of glycerine, which penetrates and replaces the acid which has evaporated, preserving the form of the zoospores; a preparation is thus made which on being sealed down will be permanent.

For the zoospores of the *Œdogonium* the process is somewhat different; they are killed by exposing the drop of water for a minute to the vapours of a 1 per cent. solution of osmic acid, and then cemented beneath the cover-glass by paraffin, coloured by carmine, and clarified by acetic acid and glycerine; the action of the carmine should be more prolonged than with the alcohol method. The nucleus, situated at the median region of the body rather nearer the posterior end, appears as a small sphere coloured red.

These zoospores were killed during their period of mobility—the nuclei could not be confused with the amylaceous corpuscles which are met with in many of the Volvocineæ by the side of the true nucleus, as the corpuscles are never coloured red in preparations prepared as above—we have therefore a true nucleus combined with vibratile cilia and contractile vacuoles.

The two algæ studied have zoospores of two different types, those of *Microspora* being flagellated, and of *Œdogonium* furnished with a crown of vibratile cilia, and M. Maupas is persuaded that if the zoospores of other algæ are examined they will all be found to have a nucleus.

MICROSCOPY, &c.

Corrosion as a Histological Method.*—The process of corrosion has been applied with considerable success to anatomical preparations. Dr. Richard Altmann, of Geissen, now proposes to apply the process to the investigation of certain microscopical structures.

The method adopted is, in the first place, to impregnate the tissue, or to inject its vessels, with olive or castor oil, then to place it in osmic acid until the oil is hardened and blackened, and finally to transfer it to a solution of potassium or sodium hypochlorite (eau de Javelle), which completely destroys the tissue, the fatty material being left, and retaining the form of the vessels or spaces into which it was injected.

Thin membranes may be placed, immediately after injection, into osmic acid, but as that reagent has very little penetrating power, large organs have to be frozen, thin sections of them cut, and these sections

* 'Arch. Mikr. Anat.,' xvi. (1879) p. 471.

placed in the acid until properly hardened. An immersion of twenty-four hours in 1 per cent. osmic acid is recommended.

During the actual process of corrosion it is advisable to place the section, or other fragment of tissue, in a glass vessel, so that it may be examined from time to time, under a low magnifying power, by transmitted light. This is rendered necessary by the fact, that if the hypochlorite is allowed to act after the tissues have been eaten away, it begins to act upon the blackened fat itself, discolouring and finally disintegrating it.

When the section has been acted upon for the right time, it is taken out of the fluid on a lifter of platinum foil, any hypochlorite adhering to it is removed with bibulous paper, and it is then examined in glycerine. A good deal of care is required in manipulating the sections, as they become by corrosion extremely tender, although the osmic acid imparts a really astonishing firmness and elasticity to the olive oil.

The eau de Javelle may be diluted, either for the purpose of watching the stages of the process of corrosion, or in the case of very delicate structures, which would be destroyed by a strong solution.

The method of oil injection and subsequent corrosion is very satisfactory for demonstrating the blood-vessels of the kidney, and those of the iris and choroid; with the latter it is especially useful, as the pigment which interferes with the examination of an ordinary injection is removed. In some cases also the oil will extravasate, fill all the cell-spaces in the tissues, and thence pass to the lymphatics. Good preparation of the minutest lymph-capillaries may thus be obtained in such cases as the frog's-skin and mesentery, the cornea of Triton, and the periosteum of the skull of mammals. In the latter case the injection is best performed by a pressure of about 3 metres of oil applied for 12 to 24 hours.

When tissues are to be impregnated instead of injectod with oil, a special *modus operandi* is employed. The oil is mixed with half its volume of absolute alcohol, and with as much ether as suffices to make the mixture clear when shaken—usually about the same quantity of ether as of alcohol is required. A fluid is thus obtained which will take up a certain quantity of water, but which, if this quantity be exceeded, undergoes a separation of its constituents. Instead of olive oil, alcohol, and ether, a mixture of two parts of castor oil with one of alcohol may be employed; the oil being soluble in all proportions in alcohol, the addition of ether is rendered unnecessary. Larger pieces of tissue, and smaller quantities of fluid, may be used with the latter than with the former mixture.

In either case, the tissue is placed in the oil mixture for 5 to 8 days. It is then transferred to water in order to precipitate the fat in the interstices of the tissue, and to wash away any that may be adhering to the surface. Next the tissue is placed for 24 hours in a 1 per cent. solution of osmic acid, and finally corroded with *aqua Javelli*, and mounted in glycerine.

Altmann has employed this method for the investigation of medullated nerve, striped muscle, epithelia, cornea, choroid, and retina.

The memoir is illustrated by three plates, which show the very striking effects produced by the corrosion process: two of his figures are reproduced on Plate XVIII.

Plate XVIII. Fig. 1.—Kidney of rabbit. Injected from renal artery with olive oil, frozen, treated with osmic acid and aqua Javelli ($\times$ 100). The large veins are seen accompanied by the finer arteries, on the branches of which are the glomeruli; one of these is filled with the blackened fat; the vasa efferentia are seen to pass into the capillaries.

Fig. 2.—Vessels of iris of tortoise. Injected from aorta with olive oil, and treated with osmic acid and aqua Javelli ($\times$ 10). The circlet of vessels is complete, but separated in preparation. From a photograph.

Staining-fluids *—Prof. H. Grenacher publishes a notice of some new methods of staining, which he considers superior to those already known, especially as applied to nuclei.

1. *Alum-carmine.*—A 1 to 5 per cent. solution of common or ammonia alum in water is boiled for 10 to 20 minutes with ½ to 1 per cent. of powdered carmine, and the solution filtered when cold. The solution is of a rich red colour, inclining to purple, and, when concentrated, stains a section in 5 to 10 minutes. Sections, when washed in water for a couple of minutes after staining, have a purple or lilac colour; the staining also is less diffuse, and more confined to the nuclei, than in the case of the ordinary solution of carmine, or picrocarmine. It also has the advantage of not overstaining even if a section is left in it for a whole day, and if it dries up by evaporation (in a watch-glass for instance), the addition of a little water will render it once more ready for use—no precipitate being produced. It is advisable to add a few drops of some antiseptic, such as carbolic acid, to the solution: it will then keep for years.

2. *Borax-carmine.*—A 1 to 2 per cent. aqueous solution of borax is boiled with ½ to ¾ per cent. of powdered carmine. To the dark purple solution acetic acid is continuously added, drop by drop, with constant shaking, until a bright red colour is attained. It is then filtered, or, as it filters very slowly, allowed to stand, and decanted.

This solution stains sections very rapidly, in from ½ to 3 minutes, but quite uniformly. If, however, they are washed with water, and placed in a watch-glass of 50 to 70 per cent. alcohol, containing a drop of hydrochloric acid, the colouring matter is removed from all parts of the tissue except the nuclei, which remain deeply stained.

3. *Alcoholic-carmine.*—To 50 cub. centim. of strong alcohol (60 to 80 per cent.) 3 or 4 drops of HCl are added, as much powdered carmine as will lie on the point of a knife is added, and the whole boiled for 10 minutes, and filtered when cold. The exact proportion of carmine and acid depend upon the quality of the former. If a section placed in the fluid stains in 5 to 10 minutes uniformly, there is not sufficient acid, and more must be added. If after standing for some days the solution acquires a yellowish-red colour, too much acid has been

* 'Arch. Mikr. Anat.,' xvi. (1879) p. 463.

added, and the excess must be neutralized by cautious addition of ammonia.

After staining, the sections must be rinsed in alcohol, not in water: also if the solution be too strong it must be diluted with alcohol, as water precipitates the carmine.

4. *Purpurin.*—About as much purpurin as will lie on the point of a knife is boiled in 50 c.c. of glycerine, the latter may be concentrated, or may have a little water added to it. The resulting orange-red fluorescent solution is allowed to stand for two or three days, and is then filtered. Unlike Ranvier's solution of purpurin, it may be kept for months without precipitation.

All the above fluids are stated to be quite permanent in the case of balsam preparations: if glycerine is used as the mounting fluid it should be slightly acidulated.

Dr. Seiler's Staining Processes.*—Dr. Carl Seiler, continuing the paper which we referred to at p. 329, gives the details of two processes, which he has found to be so universally successful that he has discarded all others.

The first is a simple carmine solution (published by Dr. J. J. Woodward in the 'Lens'), and is made as follows:—

Best carmine (No. 40)	gr. xv.
Borax	ʒ i.
Water	fl. ℥ vss.
Alcohol (95 per cent.)	fl. ℥ xi.

Mix and filter, dissolve the crystals in 8 ounces of distilled water, and evaporate over a water bath to 4 ounces.

Sections placed in this fluid will become stained very evenly in a few seconds, and be of a violet red when removed. They are then immersed in a solution of

Hydrochloric acid	1 part.
Alcohol	4 parts.

until they assume a bright rose colour, which appears in a very few seconds. The sections are then well washed in several changes of alcohol, after which they are ready for mounting.

A specimen thus treated exhibits only the nuclei with the granules stained, while the cell-contents and fibrous tissue are not tinted. This is, in many cases, of great advantage, as a much clearer picture results than if the colouring matter is also seen in the non-nucleated structures, and the nuclei are marked only by a deeper staining. If, however, for purposes of diagnosis, it is desirable to stain the contents also, this can be accomplished by using a concentrated solution of oxalic acid in alcohol, or by employing a very weak solution of hydrochloric acid after the specimen has been stained.

The second is a double staining with carmine and indigo. The sections are first stained with carmine as described above, care being taken to wash all traces of acid out of the tissues; they are then immersed in a solution of two drops of sulphindigotate of soda solution in one ounce of 95 per cent. alcohol, which should be filtered before

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 220.

using, and are left therein from six to eighteen hours, according to the rapidity with which the elements take up the indigo. When sufficiently stained the sections are placed in strong alcohol, and are ready for mounting.

The sulphindigotate of soda solution is prepared, according to the process devised by Mr. Bullock, by first digesting best Bengal indigo with Nordhausen sulphuric acid. The excess of acid is then removed by washing, the colouring matter precipitated with chloride of sodium, and left standing for several days. The precipitate is then separated from the mother liquor by filtering through flannel, and the excess of chloride of sodium washed out by pouring cold water through the filter until the colouring matter begins to dissolve. The washing is then stopped, and the precipitate dissolved in warm distilled water to saturation, which makes a solution of a deep greenish-blue colour.

The effect of this mode of staining is to leave the nuclei bright red, while the formed material of the cell is slightly tinged with blue. The connective tissue fibres become stained with a deep blue colour, while the blood-vessels are purplish and mapped out with surprising distinctness. Epithelium and hair take this staining in a very curious manner, inasmuch as the cells of different ages take different colours, ranging from a brilliant emerald-green to purple-violet and olive-green, thus affording a valuable means of differentiation, especially in epitheliomas, where the so-called pearls are brought out with great distinctness, being of a different colour from the rest of the cells.

This process seems somewhat troublesome, especially if the microscopist attempts to make the indigo solution himself. But, even if it should prove so, the result obtained is well worth the pains taken, and fully repays the outlay of time and patience bestowed upon it.

Isolation of the Optic Nerve Fibres and Ganglion Cells of the Mammalian Retina.*—Dr. George Thin, in an article in the 'Journal of Anatomy and Physiology,' says that the isolation of the ganglion cells and optic nerve fibres of the retina has certainly not been found by histologists to be invariably an easy task, and he can testify from experience that methods which are well fitted for the observation and study of other parts of the retina, destroy the processes of the ganglion cells and the nerve fibres. Max Schultze has acknowledged this difficulty in his article on the retina in Stricker's 'Handbuch,' published in 1872. Dr. Thin is induced, therefore, to believe that the publication of a method by which he found the isolation of these elements singularly easy, may be considered justifiable.

The method holds good for the retina of the cat and the sheep; but there can be little doubt that it will prove equally useful in the case of many other mammalia. His observations have been limited to the eyes of these two animals.

It is well known that if a sheep's eye be placed in a sufficient

* 'Journ. Anat. and Phys.' (Humphry), xiii. (1879) p. 139.

quantity of alcohol for twenty-four hours, and at the end of that time be laid open, and the retina be then examined in glycerine, the optic nerve fibres and ganglion cells will be found more or less well preserved. But it is a matter of no small importance to regulate the strength of the alcohol, and diluted alcohol will be found more useful than strong alcohol. A mixture of equal parts of methylated alcohol and water is a strength that he used for some time, with such excellent results that he adhered to it during most of the time that he was engaged in examining this part of the retina; but latterly he found that, in most respects, a weaker strength secured as good preparations, and for some purposes produced better ones. For the preservation of the processes of the ganglion cells, mixtures of one part of methylated alcohol with two of water, and of one of methylated alcohol with three of water, are peculiarly well adapted. The fibres of the optic nerve expansion are well seen, whichever of these strengths is used. They may be isolated in great numbers, and for great lengths, after the bulb has been in equal parts of water and alcohol. When only a fourth strength of alcohol was employed, the nerve fibres were, unless well teased out, slightly obscured by adherent granules—probably the remains of connective substance of the layer.

When the strengths of a third and a fourth were used, the bulb was allowed to remain in the fluid for thirty-six or forty-eight hours.

Although both the ganglion cells and the nerve fibres in eyes, treated by the above methods, can be examined at once in glycerine, it may be found advantageous to subject the retina to other processes, through which the hardened nerve elements can now pass without injury. It may be placed first in water for a short time, and then may remain overnight in staining fluids, and finally be examined and preserved in glycerine, or, after being stained, it may be passed through alcohol and oil of cloves, and preserved in dammar varnish. The glycerine preparations show both the fibres of the optic nerve expansion and the ganglion cells. The dammar preparations are useful as permanent specimens of the nerve fibres. In either case some careful manipulation with needles is necessary to disentangle the nerve fibres, a process which is particularly troublesome in the dammar preparations. Of all the staining fluids tried, a solution in water of aniline blue was found to be by far the best. For the nerve fibres aniline blue alone is sufficient; for the ganglion cells a double staining with aniline blue and eosin is useful.

Eyes which have been placed in alcohol, as above directed, may be preserved for a long period in glycerine without the nerve fibres or ganglion cells suffering in the least. The effect of the glycerine by its affinity for water is to produce a complete collapse of the eyeball. The lens preserving the shape of the anterior part of the bulb, the posterior half is doubled up into the anterior half, forming a cavity at the bottom of which is the stump of the optic nerve. It is thus possible to prepare eyes at any time, and keep them ready for examination. He had excellent preparations of the optic nerve fibres and ganglion cells from the eye of a kitten, which, after being twenty-

four hours in equal parts of methylated alcohol and water, had been kept sixteen months in glycerine.*

Preparation of Diatoms in situ: means of avoiding Air-bubbles.†—M. Petit, referring to the process of Brebisson of preparing *Odontidium Tabellaria*, viz. by placing the filaments on thin glass or mica, and heating on a plate of platinum, says that this presents serious difficulties to amateurs who regard the beauty and cleanness of their preparations. In the first place, it is rare that we are able to carry the calcining sufficiently far to completely destroy the cellulose, which reduced simply to charcoal blackens the frustules; secondly, preparations thus calcined are with difficulty penetrated by Canada balsam, even although care may have been taken to make it sufficiently fluid by the addition of an essential oil, &c.; thirdly, in calcining on the cover-glass only one of the faces of the diatom is ordinarily seen, whilst it is often essential in determining the species to see the two aspects.

He therefore proposes the following method to get rid of these inconveniences. He places the diatoms (previously washed in fresh water if they are marine) in concentrated cold nitric acid for twelve hours; this time is sufficient to "nitrify" the cellulose, without destroying it or dislocating the filaments. After sufficient washing, they are placed on the cover-glass, and calcined to a red heat on a plate of platinum until the deposit has become white; it is then easy to make dry preparations in which there is no deposit of charcoal; for in this case the cellulose, owing to the action of the nitric acid, is destroyed without appreciable residue.

To avoid bubbles of air with Canada balsam, he makes use of oil of lavender, placing a small drop, after the calcination and when the preparations have got cold, on the cover-glass; this infiltrates into all the cavities, and facilitates the penetration of the balsam. The cover-glass should then be placed on a drop of balsam deposited on the slide, and heat applied with a spirit lamp, so as to drive away the oil of lavender and to evaporate a part of the balsam.

In order to prepare diatoms *in situ* in their various aspects on one slide, he boils about the third part of the collection, and mixes this, after washing, with the two other parts, treated with cold nitric acid as above mentioned, and thus obtains excellent preparations containing both diatoms *in situ* and those separated, which is of great advantage for study.

Mechanical Turntables.‡—Mr. Spencer Rolfe, referring to Mr. Rogers' electrical mounting table,§ says that some time since he

* The method is one that might be used for the examination of the retina of rare animals when the eyes have to be procured from a distance. After the remarkable observation of the anastomosis of the ganglion cells of the elephant's retina by Corti, to which there has been as yet no parallel, a further examination of the retina of that animal is very desirable. The eyes of elephants in a condition suitable for such an examination are not easily procurable, but by the use of the above method available specimens might be had from India.

† 'Brebissonia,' i. (1879) p. 121. ‡ 'English Mechanic,' xxix. (1879) p. 139.

§ This Journal, ii. (1879) p. 469.

thought he would apply clockwork to a table, but on considering the matter, it seemed unnecessary to give it a continuous motion, as a slide can be ringed in a very short time, and the table must then be stopped to remove it. He therefore adopted a method which he considers simpler, more convenient, and less costly.

The milled portion which is used to spin an ordinary turntable is replaced by a small cog-wheel, and in a horizontal slot in the mahogany support, in a line with this wheel and gearing into it, is a segment of about one-sixth of a cog-wheel, say 4½ inches diameter; this segment is continually pressed by a strong spring to the left-hand side, against a small indiarubber stop, and has then moved so far as to be out of gear with the small wheel, and plenty of clearance. A trigger in the form of a hook, working vertically in the mahogany—the hook catching the lower side of the segment when pushed over—completes the arrangement. The action is as follows:—The segment is pushed over and is held by the catch, the slide being in position. On placing the hand holding the brush on the support, the catch is released, the segment flies round, carrying the table round in the opposite direction; and clearing it, the table continues to revolve. If we could only manage to remove and replace the slides, a moderately well-balanced and weighty table would turn a sufficient time to ring, perhaps, five or six slides.

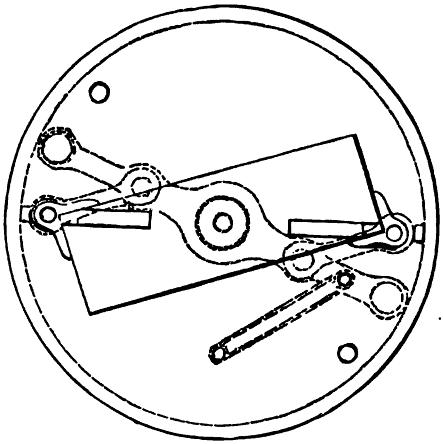
Improved Turntables.*—Mr. Rolfe also communicates the following (the apparatus having been exhibited at a recent meeting of the Quekett Microscopical Club):—My object has been to remove the following objections which I have experienced whilst using the ordinary turntable. A slide having been partly finished and allowed to dry, it is very difficult to replace it with the cell or ring of varnish perfectly centered, and indeed with great practice such can only be done by a considerable expenditure of time and patience. Again, should a very delicate object be mounted, it is very often driven with the rush of fluid near the outside of the cell, and unless the finishing ring of varnish can be put on correctly it stands great chance of being covered by it. With only the springs to hold the slide it is constantly shifting about, and I have found it most annoying when, as has frequently happened, I have spoilt a carefully mounted object from this cause.

My first endeavour to avoid these disadvantages is shown in Fig. 1. It consists of a parallel system of levers, actuating two clips, working in slots in the table, each clip embracing one corner of the slide. The clips are constantly drawn together by an elastic spring. I found this work admirably for a time, but by wear the slides were not correctly centered, and I found moreover that nearly every slide I used was a trifle out of square, and it was therefore necessary to take care that the same corners were always engaged by the same clips. This fact gave me the idea of a far simpler and equally efficient turntable, shown in Fig. 2. The top A has two small pins B B projecting about the thickness of a glass slide, and diagonally opposite

* 'English Mechanic,' xxix. (1879) p. 365.

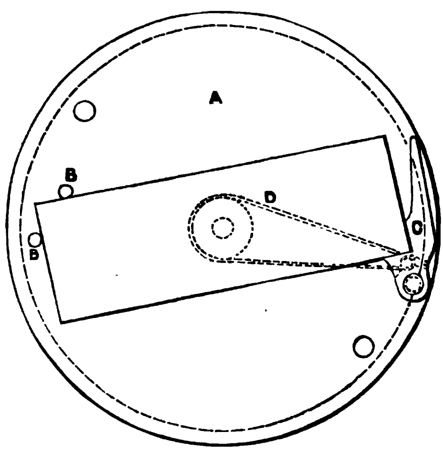
these is a catch C, a pin from which projects through a slot in the table, and is drawn towards the centre by a spring, shown dotted. This I find acts admirably in every way, and provided the slide to be

FIG. 1.



re-ringed has been previously ringed in it, it will always go back truly centered. The stops B B are placed in such a position that the centre of the slide is a little out of truth with the centre of the table, and it

FIG. 2.



is then seen in a moment, when a slide is placed in the clip, if the right corners are engaged, and if not correct it only requires reversing end for end. Glass cannot be held in a rigid grip, and I find the

pressure given by common elastic bands admirable, and they can be renewed at a nominal cost.

The two holes shown in both the tables are to take springs in order to be able to use it in the usual way for old slides. I have found it of great advantage to make the support for the hand (not shown in the figures) slide back so as to be able to take in exceptionally large or deep cells.

Large Micro-photographs.*—Dr. S. Th. Stern says that to obtain a micro-photograph on a large scale the screen of the camera has to be placed at too great a distance from the objective for the operator to be able to adjust the focus without complicated machinery for connecting the fine adjustment with the camera which is uncertain in action, troublesome to work, and of considerable cost. He dispenses with the machinery by simply placing a mirror behind the ground-glass screen. The image thrown upon the screen is reflected in this mirror, and may be viewed through an opera-glass by the operator as he stands by the objective and adjusts it. The adjustment is effected by this means with the greatest ease.

Dr. Sorby at Cambridge.—The following neat reference to Dr. Sorby's labours made by the Public Orator at Cambridge on the occasion of conferring the LL.D. degree, may appropriately find a place in this Journal which numbers so many readers "*qui minuta curiositate arcana illa quæ oculorum aciem fugiunt instrumentorum novorum auxilio perscrutantur*":—

"Quam magna est rerum natura, in magnis quam immensa, in minimis quam magna! Quam multa miracula, antiquis ignota, illis nuper ostendit qui minuta curiositate arcana illa quæ oculorum aciem fugiunt, instrumentorum novorum auxilio perscrutantur! Hic autem ille est qui, et terrestrium et de cælo delapsorum lapidum investigandis elementis primis, primus inter Britannos talium instrumentorum usum accommodavit. Nuper Societatis Geologicæ præses electus, annorum triginta labores oratione cumulavit in qua vere marmoreum sibi monumentum exegit.† Illud vero acutissimum quod crystallis etiam minutissimis exploratis in quibus (ut fit) pars altera est aquæ plena, altera aëris quoque vacua, olim indicavit qua potissimum caloris temperie inclusa illa aqua totum illud vacuum implere, quo potissimum rerum statu saxum illud, quondam ignibus prorsus liquidum, primum durescere potuisset. Scilicet crystallum illud (ut Claudianus ait)

'Non potuit toto mentiri corpore gemmam,
Sed medio mansit proditor orbe latex
Auctus honos; liquidi crescunt miracula saxi
Et conservatæ plus meruistis aquæ.'

Suo phaselo vectus quot maria mox lustrabit, in terra iam pridem unum saltem Argonautarum, qui terram oculis penetrabat, eatenus æmulatis, quod in intima saxorum materia perspicienda, ipse oculo

* 'Zeitsch. Mikr.,' i. (1879) p. 321.

† In allusion to Dr. Sorby's Presidential Address "On the Structure and Origin of Limestones."

potuit 'quantum contendere Lynceus.' Duco ad vos Henricum Clifton Sorby."

Unit of Micrometry.*—Referring further to this subject, Professor Romyn Hitchcock points out that the resolution of the Indianapolis Congress did not deal as is sometimes supposed with a unit for micrometer-makers to subdivide, for which the $\frac{1}{100}$ of a millimetre would probably be the most appropriate subdivision, but with a *unit* in the sense of the smallest whole number used in giving dimensions.

The $\frac{1}{1000}$ mm., the so-called micromillimetre, or *micra* of the French (designated μ), appears to him more suitable for the *unit.* A few examples of its application may serve to support this view.

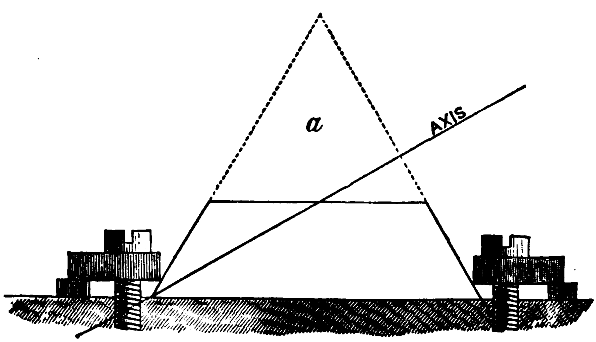
The diameter of a human blood-corpuscle is about $7 \cdot 7\ \mu$ ($\cdot 0077$ mm.). In birds, the corpuscles measure from 12 to 14 μ in one direction and from 6 to 8 μ in the other ($\cdot 012$ to $\cdot 014$ mm. $\times$ $\cdot 006$ to $\cdot 008$ mm.). The corpuscles of *Proteus anguinus* measure 58 μ, and still larger are those of *Amphiuma tridactylum*, 175 μ ($\cdot 058$ and $\cdot 175$ mm.).

If the reader will assume some other unit, as the cm., or mm., or even the $\frac{1}{100}$ mm., and endeavour to express the same dimensions in these terms, the advantage of the micra will, he thinks, be obvious. With it a single decimal is sufficient for ordinary purposes.

Formation of the Paraboloid as an Illuminator for the Microscope.†—In an article in the 'American Quarterly Microscopical Journal' Mr. Wenham gives some useful information relating to practical methods of obtaining parabolic forms.

The glass parabolic illuminators are ground up to form by means of templates. These may be accurately formed by a purely mechanical method, based on the principle that every section of a cone taken in a plane parallel to the opposite side, is a parabola. Proceed as follows:—

FIG. 1.



Turn a cone either of metal or hard wood, between the lathe centres, then on the face plate (which of course should run quite true) chuck the cone on one side, either by cement or clamps as shown in Fig. 1.

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 235. † Ibid., p. 186.

With the slide rest take off the section *a*, remove the cone, and on the parabolic face screw a well-flattened piece of sheet brass slightly exceeding it in size; back this up by a block of the same wood as the cone; fix both thereto by two countersunk screws passing through holes drilled in the brass plate. The cone is now returned to the lathe centres and the surplus piece of wood turned down, together with the edge of the brass plate, by means of the slide rest till the cone is again complete. A dead smooth file may then be held against the

FIG. 2.

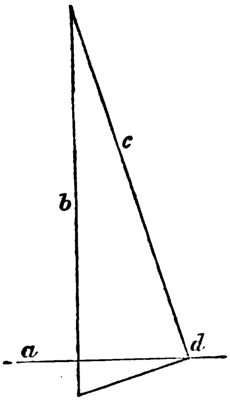
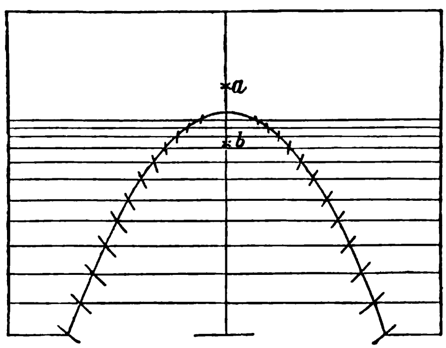


FIG. 3.



revolving cone; this trims the edge of the contained template which comes out as a true parabola. Unless this is made to match a parabolic figure of known focus, it may be necessary to ascertain the focal point of the blank parabola. This can be easily found as follows (Fig. 2):—Draw a line *a* equal to the diameter of the base of the parabola; take a perpendicular to this *b*, equal to the height from the base to the

EXPLANATION OF FIGURES.

FIG. 1.—A wooden cone clamped down by screws on to the face plate of a lathe. The axis from which the cone was turned inclined in the direction shown. The dotted section *a* is turned off parallel with the opposite side; on the parabolic face the template is formed.

FIG. 2.—Method of finding the focal distance of a blank parabolic figure.

a. Diameter of base.
b. Distance from base to vertex.
d Half the semidiameter.

Connect *d* with end of *b* by line *c*; a perpendicular from this, taken from *d* at the point where it intersects the axis below the base, will be equal to the focal distance below the vertex.

FIG. 3.—Outline of rectangular brass plate to form a template for paraboloid.

b. Focal distance.
a. Equal to focal distance above vertex of parabola.

Cross lines drawn at irregular but increasing distances, as shown, measurements on the axis, by compasses, from *a* to each of these lines; each line bisected by the same measurements from the focus or point *b* describes the outline of a parabola.

The dotted segment of a circle is struck from the focus *b* representing a non-immersion paraboloid.

vertex; from the termination of the perpendicular take a line c intersecting the half-diameter of the base line at d; another line is set off from this point at right angles to c; the distance at the intersection of the axis beyond the base line will be the required focal distance of the parabola.

To those not possessing the requisite tools, this method of cutting out a template, of course, cannot be available. The plan of drawing with a square and piece of string, described in all elementary works on geometry, is so irregular in its action, as to be useless for small parabolas; bisection must therefore be resorted to, which by careful manipulation gives a very true figure. This operation depends upon the following property of a parabola: that any point taken on the axis at a distance beyond the vertex equal to the distance of the focus within it, to any transverse line on the axis, will be equidistant from the same line to the focus. Proceed as follows:—

Provide a thin brass plate (Fig. 3) perfectly square and flat, of sufficient size to enclose the required parabola for which it is to serve as a template. In a centre line quite parallel with the sides, prick off two equidistances, the directrix a without, and the focus b within the vertex of the parabola. Draw a number of parallel lines at right angles across the centre line; these lines need not be set at any particular distance, but may be ruled at sight, taking the precaution of setting them close together towards the vertex, and progressively increasing the distance between them towards the base. With fine-pointed dividers, take the distances of these lines on the axis from the directrix or outside mark a in succession. For each measurement, shift the point to the focus b within the vertex, and bisect the line from which the distance was taken on both sides; the intersection of all the lines by the arcs from the focus will give the outline of a true parabola. The crossing points are now to be dotted in with a thin, sharp-pointed centre punch applied at the right spot under a hand magnifier. The surplus brass is cut out with a fine saw, and the template carefully filed up till the punch marks appear as sunk in the metal.

The block of glass if intended for a flat-topped or immersion paraboloid, should have both its base and apex polished off to the right thickness before it is cemented to the lathe-chuck with black sealing-wax. By means of the rough edges of an old saw-file, ground on one side and used with plenty of turpentine, the glass is turned away at a very slow speed till it is seen approximately to fit the template. The edges of this are then slightly smeared with reddle and oil, and the paraboloid fine turned with a keen edge, until the template marks it evenly all over. In order to take out the rings left from the turning, a block of brass, not larger than half an inch square, is traversed over the revolving glass with coarse and then smoothing emery, till all scratches disappear. The glass is then polished with a buff-stick, and crocus and water, and finally a piece of hard beeswax is held against it with finer crocus, in order to obtain the last degree of polish.

If the paraboloid is to be a non-immersion one with a cupped top, it may be turned flat on the end till the required thickness is arrived at and the hemispherical cavity roughly turned out to a half-circle

template till the centre is brought to the focus; the cavity is then finished in the same way as a concave lens. Finally, while rotating in the lathe the paraboloid is perforated through the axis with a steel drill and turpentine.

Paraboloids can be made true enough for most purposes if finished as above described; but if great accuracy is a desideratum, the figure may be corrected after the rough turning by means of the following appliance.

It is a property of the paraboloid that the face of every section taken parallel to the axis, is an exact counterpart, and, in form, is the same parabola. This enables us to verify and correct the figure. From the further end of a base board, clamped to the bed of the lathe, hinge a piece of board about two inches wide. Let this be so adjusted that when the front edge is raised, the upper plane of the board falls exactly parallel with the lathe centres. Rough file out a piece of sheet brass, something like the template, to serve as a grinder. Lay this on the face of the hinged piece of wood, and press it up on the revolving glass, smeared with fine emery and water. After a few turns, lower the board and shift the brass grinder endways to another position, either in or out. Repeat this continually, occasionally turning the brass over to equalize the sides. By this operation the parabolic figures, of both the grinder and the glass, will soon correct each other. Of course a piece of the swing board must be scooped out sufficiently to admit nearly half the paraboloid.

In accordance with the above mode of procedure, the parabola is originated and its size predetermined by the given focal distance. The ordinary dry parabolic illuminator is usually made about $\frac{1}{8}$ inch focus; for an immersion $\frac{1}{10}$ will do better; but if this is to be used as an animalcule-holder, $\frac{1}{15}$ will be found sufficient.

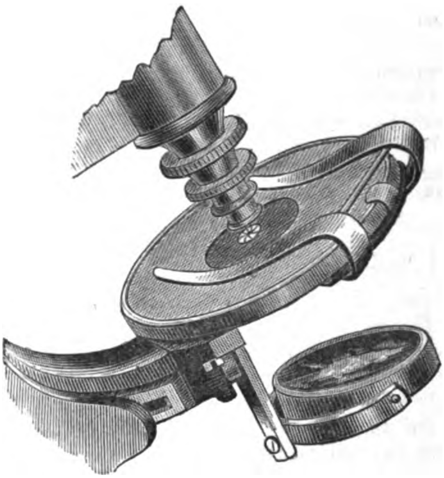
Black-Ground Illumination.—Mr. Wenham in the same article says, that he has never seen minute organisms or animalcula so beautifully displayed as by the truncated paraboloid described in a paper published in the 'Transactions of the Microscopical Society of London' in 1856. The paraboloid is mounted so as to be used also as an animalculæ cage or live box, the object to be placed in water on the flat top, and confined by a thin glass cover; rays from a lamp made parallel to be sent in beneath, using a dry object-glass. The minutest details are visible in their true colours on a black field. He is not aware that anyone has provided himself with this piece of apparatus, and the knowledge of its effects probably does not extend beyond the half-dozen friends who have seen his demonstration.

Rotating Clips for Cheap Microscopes.*—The rotating stage, when well made, is acknowledged to be a most important and useful addition to any Microscope. It has this objection, however, that when well made it is expensive, and when badly made it is worthless. Moreover, it adds considerably to the thickness of the stage, thus interfering with the use of very oblique light.

* 'Am. Journ. Micr.,' iv. (1879) p. 93.

In the new Microscope of Mr. George Wale these difficulties are obviated by means of a rotating clip, shown in the annexed woodcut.

In this form the stage is circular, but immovable; near the outer edge of the stage, both on the upper and the under sides, are two narrow circular grooves, in which slide two pins attached to a bar, which lies beneath the stage (as shown in the figure) and which carries the clips. To the middle of the bar is attached a spring, which keeps the frame of the clips in place on the stage.



This arrangement not only allows the clips to rotate round the stage, and thus permit the object to be placed in any direction as regards the light, but it enables the microscopist to remove the clips instantly from the stage, and thus leave a clear space for work when the Microscope is used in a vertical position. The clips may also be placed on the under side of the stage, so as to hold the slide from beneath. In this way light of the utmost degree of obliquity may be used, as the stage then virtually has no thickness whatever.

Contrivance for holding Objects beneath the Stage.*—Dr. Phin himself describes in his Journal the contrivance which we quoted and figured under this heading (at p. 466) from an English contemporary. In addition to what is there said, Dr. Phin remarks that another important feature of the sub-stage is that if the spring clips be made very light the arrangement serves as a safety stage, and the most delicate slides may be used even by bunglers without danger of having the slide or cover fractured.

* 'Am. Journ. Micr.,' iv. (1879) p. 92.

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WACKERNAGEL, P.—Preparation of the Diatomaceæ. (2 figs.) *Zeitschr. Mikr.*, II., pp. 57–68.

WICHMANN, Dr. A.—A Microscopical Study of some Huronian Clay Slates. *Quart. Journ. Geol. Soc.*, XXXV., pp. 156–64.

APPARATUS for Cutting Thin Covering Glass. (1 fig.) *Zeitschr. Mikr.*, II., pp. 77–9.

BROECK, E. VANDEN.—Description of a New Kind of Slide for Mounting Dry Preparations, and specially applicable to Collections of Foraminifera, Entomostracæ, &c. (1 plate.) *Mém. Soc. Belg. Micr.*, IV., p. 111–18.

D'ARSONVAL.—Remarks on the Microscope. *CR. Soc. Biol. Paris*, XXIX., pp. 124–5.

GUNDLACH, E.—New Quadruple Objective for Astronomical Telescopes. (4 woodcuts.) *Proc. Am. Assoc.*, 1877 (1878), pp. 127–34.

KAISER, Dr. E.—Microscopy at the Berlin Technical Exhibition in 1879. I. *Zeitschr. Mikr.*, II., pp. 69–73.

LOCOCK, W.—"Centerer" for Slides. (1 fig.) *Sci.-Gossip*, No. 175, p. 160.

M. Dr.—Microscopic Cleanliness. ["Patent Chequered Pumice Tablet," for Removing Stains of Balsam, Pigments, Varnishes, &c.] *Sci.-Gossip*, No. 175, pp. 159–60.

MICROMETRY, National Committee on. *Am. Journ. Micr.*, IV., p. 114.

PELLETAN, Dr. J.—The Oil Question at the Royal Microscopical Society of London. *Journ. de Micr.*, III., pp. 234–7.

VEEDER, M. A.—Lead Cells. *Am. Nat.*, XIII., p. 409.

WARD, R. H.—A Modification of Wenham's Reflex Illuminator. *Proc. Am. Assoc.*, 1877 (1878), pp. 205–6.

ZEISS's Travelling Microscope. (1 fig.) *Zeitschr. Mikr.*, II., pp. 16–19.

PROCEEDINGS OF THE SOCIETY.

MEETING OF 11TH JUNE, 1879, AT KING'S COLLEGE, STRAND, W.C.
THE PRESIDENT (DR. BEALE, F.R.S.) IN THE CHAIR.

The President having called upon the Secretary to read the minutes of the preceding meeting,

Dr. Millar asked leave to make an amendment to one portion of the report—that which related to the thanks of the Society having been voted to the library committee for their services in arranging the new room. He thought that special reference should have been made in that vote to Mr. Crisp and to his donation of the three handsome chairs for the President and Secretaries now before them, and he begged to move that the thanks of the Society be given accordingly.

Mr. Glaisher said that Mr. Crisp seemed determined to lay the Society under as much obligation as possible, for in addition to his other services, and to his great share in the production of a Journal which they might justly be proud of, he had made them this present. He had much pleasure in seconding the vote of thanks.

The motion having been put and carried unanimously, the minutes of the preceding meeting were read and confirmed.

The President said that before proceeding to the business of the meeting, he had a sad duty to perform in announcing the loss of one of their most valued Fellows, Mr. Charles Brooke, F.R.S., who was well known amongst them from his past services as member of the Council and twice President.

Mr. Glaisher said that the loss which they had experienced was indeed a serious one. Having known Mr. Brooke for many years, he could speak to the deep interest which he took in the welfare of their Society, and his readiness at all times to do his best to advance microscopical science. He had therefore risen to move that a letter of condolence should be forwarded to Mr. Brooke's relatives on behalf of the Society, expressing their sense of the great loss which the Society had sustained, and their appreciation of the benefits which it had derived from Mr. Brooke's association with them.

Dr. Millar having seconded the motion, it was carried unanimously.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors; special reference being made by the President to the handsome volume presented by Mr. Glaisher.

	From
Certes, A.—Sur une Méthode de Conservation des Infusoires. (Extracted from 'Comptes Rendus.') 1 plate	*The Author.*
Hyatt, J. D.—The Sting of the Honey-Bee. (Extracted from the 'Am. Quart. Micr. Journ.') 9 pp., 2 plates	*Ditto.*
Report upon United States Geographical Surveys West of the One Hundredth Meridian. Vol. iv. Palæontology. 4to. Washington, 1877. 219 and 370 pp., 83 plates	*Mr. Glaisher.*

	From
Slack, H. J., F.G.S., &c.—Marvels of Pond Life. 3rd edition. 158 pp., 7 plates and 50 woodcuts. 8vo. London, 1878.	*Mr. Crisp.*
Van Heurck, H.—Le Microscope: sa Construction, son Maniement, et son Application à l'Anatomie végétale et aux Diatomées. 3rd edition. 346 pp., 12 plates and 170 woodcuts. 8vo. Bruxelles, 1879	*The Author.*
Woodward's Prism. (Described in 'Journ. Roy. Micr. Soc.,' i. (1878) p. 246.)	*Mr. Crisp.*
Young's Camphine Lamp Cotton, for distribution among the Fellows	*Mr. W. T. Suffolk.*
Zittel, K. A.—Beiträge zur Systematik der fossilen Spongien. 132 pp., 10 plates. 8vo. Stuttgart, 1879	*Mr. Crisp.*

The President said he had much pleasure in announcing that they were favoured that evening by the presence of a distinguished Honorary Fellow of the Society—Professor Abbe, of Jena—who would read a paper "On a New Method of Correcting Spherical Aberration."

Professor Abbe on rising was very warmly received by the meeting, and proceeded to explain the method which he had adopted for correcting spherical aberration, illustrating his remarks by diagrams on the black-board as he proceeded. He also exhibited an objective in its complete form made upon the new principle.

The President, in moving a vote of thanks to Professor Abbe for his communication, felt sure that the meeting must have been highly gratified by his very clear explanation of a difficult subject.

Mr. Wenham said it appeared to him that Professor Abbe had mooted a very important question in reference to the difference between the magnifying power of the centre and the margin of the field, which had not yet been properly investigated. He wished to ask Professor Abbe whether he found that this distortion bore any regular ratio to the angle of aperture?

Professor Abbe said that the difference of amplification was not the same as distortion. It was a difference of amplification which might arise in the centre of the field of view from difference of conjugate points. It was quite distinct from the distortion due to different amplification in different parts of the field.

Mr. Palmer inquired what particular form of front lens was employed.

Professor Abbe said he had brought one with him to show the construction. It was a lens about 5° greater than a hemisphere, and was mounted on a very thin plane plate of glass, of somewhat greater diameter than the plane face of the lens, the projecting zone serving for the mounting in the metal cell. This the Professor exhibited, also giving a diagram showing the posterior lenses in the combination, and explaining wherein the new arrangement differed from previous combinations. Very great difficulty had been met with in producing accurate figure to the edge of this new front lens; he could, however, vouch for the fact that excellent figure had been obtained up to 5° or 10° beyond the hemisphere.

Mr. Beck thought they must all feel very much indebted to Professor Abbe for bringing this subject before them, but he wished to inquire whether the plan which he had suggested for doubling up

(so to say) the red and blue rays at the margin of the object-glass was not somewhat similar to the effect produced in the eye-piece of the telescope by making the red and blue rays cross over.

Professor Abbe said that there was a certain similarity, but there was also a considerable difference. He then further explained by means of drawings the course taken by rays departing from different points and passing through the object-glass.

Mr. Ingpen hoped that in passing a cordial vote of thanks to Professor Abbe, they would not omit to compliment him upon having taken a course so very rarely pursued by those who worked at the theory and practice of optics; he had not only made a most valuable improvement in objectives, but had at once explained its principles and method of construction.

Mr. Crisp said that they had to signalize the presence amongst them that evening of an Ex-officio Fellow, elected under the amended Bye-laws—Dr. H. E. Fripp, the President of the Bristol Naturalists' Society—who was, he believed, the first Ex-officio Fellow (not being also an Ordinary Fellow) whom they had yet had the opportunity of welcoming. Dr. Fripp had (as he expressed it,—by way of recognition for the compliment paid to his Society) sent them a most valuable paper "On the Theory of Illuminating Apparatus employed with the Microscope." The paper was a long one, and at that late hour they could not do justice to it in full, but he would earnestly recommend all working microscopists to study the paper when it appeared in the Journal.

Portions of the paper were then read (see p. 503).

The President having invited Dr. Fripp to make some remarks,

Dr. Fripp said that he rose, not to speak about his paper, but to allude to the circumstance of his being present with them on that occasion, no longer as a visitor, but by the courtesy of the Society as one of its Fellows. For this courtesy he desired to show himself grateful in the directest manner which common sense dictated, namely, by accepting the good things which came in his way, and evincing his appreciation by hearty enjoyment of them. But he wished also, as one of the first of the Ex-officio Fellows under the new rule, to add that he thought the step taken by the Society in holding out a hand of fellowship and help to those at a distance who were working with less advantages to the same end rightly accorded with the true instincts of science and the enlarged spirit of the age. He therefore felt that those who were thus favoured were called upon to make whatever humble return they might be able.

Mr. Beck much regretted that an opportunity had not been afforded of having a discussion on the subject of Dr. Fripp's paper, as it had a very important bearing on the practical working of the Microscope. Just lately a person described to him some very remarkable appearances which he had observed, and he was enabled to show that they were entirely due to a defect in his illuminating apparatus. He thought that it would be well to have a full discussion on the subject.

The President said that from pressure of time, as they had other

papers before them, it would be necessary to postpone the discussion—a postponement which was the less to be regretted, inasmuch as Dr. Fripp had been kind enough to promise them a second paper on the subject at an early date, when the discussion could take place with the advantage of their having then had an opportunity of reading the present paper in print.

Dr. W. M. Ord then stated the chief points in his paper, "On some Causes of Brownian Movements."

Mr. Wenham said that Dr. Ord appeared to have experimented on substances which were liable to change, and inquired whether he attributed the movements to decomposition, and whether they were found eventually to cease.

Dr. Ord said that the movements he had described went on as long as they could be observed. Decomposition no doubt had much to do with the movement in question, but not putrefaction; and chemical metamorphoses appeared to play a very important part in it.

Mr. Wenham remembered about twenty years ago experimenting with a mixture of oil and albumen, and in one case he obtained a very curious effect: having confined some of the substance in a small space so as to get a narrow channel full of molecules, he found that when they could not move laterally, they kept up a continuous movement along the channel in a manner which very closely resembled cyclosis in plants.

Dr. Ord mentioned another interesting experiment. If a small quantity of white of egg was diluted with one-third its volume of water, and to this was added one-tenth the quantity of liquor potassæ, and then some oil were mixed with it (by preference neat's-foot oil), and this mixture were left for a fortnight or three weeks, they would find in the first place a number of molecules covered with laminæ of coagulated albumen. In a certain number of these they would find an interior globule with a pellicle of its own, and sometimes they would also find these filled with a number of the most minute molecules all engaged in the quickest possible Brownian movements.

Mr. Wenham said he had in his possession a slide of quartz containing a small bubble of liquid—supposed to be carbonic acid—which had a continuous motion, and this had been going on many years.

Professor Kellicott's letter to Mr. Crisp as to *Anuræa longispina*, described at p. 157, was read, in which he said, "It is a poor traveller, and is at present known only in the water supplies of cities along the Great Lakes, and obtained by filtering the water through muslin, by which process a sediment of dirt and living forms is obtained, with which the rotifer soon gets entangled, and then dies. When they are plentiful, usually during the autumn, clean gatherings are to be had. I have made many trials at capturing them since receiving your letter asking me to send some, but thus far without success. I will keep a look-out for them, and will send a good sample as soon as they can be had."

The following five Papers were taken as read in consequence of want of time:—

Mr. H. J. Carter, F.R.S.: On a New Species of Excavating Sponge (*Alectona Millari*); and on a New Species of Rhaphidotheca (*R. affinis*). (See p. 493.)

Mr. H. J. Carter, F.R.S.: On a New Genus of Foraminifera (*Aphrosina informis*); and Spiculation of an unknown Sponge. (See p. 500.)

Colonel J. J. Woodward, Hon. F.R.M.S.: Observations suggested by the Study of *Amphipleura pellucida*, mounted in Canada Balsam, by Lamplight and Sunlight, with various Objectives.*

Colonel J. J. Woodward, Hon. F.R.M.S.: Note on Abbe's Experiments on *Pleurosigma angulatum*.

Herr A. Grunow, Hon. F.R.M.S.: New Species and Varieties of Diatomaceæ from the Caspian Sea; Translated, with additional Notes, by F. Kitton, Hon. F.R.M.S.

Mr. Crisp said that, in accordance with the views expressed in the last report of the Council, he had from time to time prepared notes of recent observations, illustrated with diagrams, but at none of the meetings had there been any time for him to deal with them, owing to the other business. As the session was now closing, it would be useless to hold them over longer, and he proposed to print one of them in the next number of the Journal, viz. Professor Balbiani's "Observations on *Notommata Werneckii*, and its Parasitism in the Tubes of Vaucheria" (see p. 530), and later, if space allowed, Professor Malassez's "Correction of the Distortions produced by the Camera Lucida of Milne-Edwards and of Nachet," and "Note on the Measurement of Microscopic Amplifications."

The President in wishing the Fellows a pleasant vacation said that they might all congratulate themselves upon the present position of the Society. Many improvements had recently been carried out; their finances were in an exceptionally favourable state, the capital account having been increased, and the revenue for the present year being no less than 200*l.* in excess of that of last year; they had acquired the use of the excellent room in which they were assembled, and they had had nearly fifty applications for Ordinary Fellowship, which Mr. Crisp told him was an unprecedented increase in so short a time, there being still three more meetings to complete the year. He hoped that they would continue to prosper, and that the Fellows would not be idle during the recess, so that they might have a good number of interesting subjects for consideration when the meetings were resumed.

The following Objects, Apparatus, &c., were exhibited:—

Professor Abbe:—Objectives and combinations of lenses illustrating his paper.

Mr. A. de Souza Guimaraens:—Diorite (Napoleonite); Diorite (quartz); Hauyne; Lava (Vesuvius); Liparite (Sphærulitic). (Prepared by Dr. Eduard Kaiser, of Berlin.)

* The photographs did not arrive in time for the meeting, but will be exhibited at the October meeting.

Mr. Loy:—Larva of *Odonestis potatoria* (the Drinker Moth).

Mr. F. M. Rogers:—Electrical mounting table, described at p. 469.

Mr. Crisp:—(1) Professor A. de Lasaulx's apparatus for determining the angle of the optic axes of crystals with the Microscope, described at p. 191. (2) Fresh-water *Mysis* from Buffalo, referred to at p. 52, with some undetermined Rhizopods adhering to it (sent by Professor D. S. Kellicott, of Buffalo). (3) *Uroglena volvox* (from Mr. Bolton).

New Fellows:—The following were elected *Ordinary Fellows*:—Messrs. H. S. Carpenter, F.C.S., A. C. Cole, J. A. Douglas, Romyn Hitchcock, G. L. Nichols, J. Stubbins, and T. E. Watson.

The Presidents for the time being of the following Societies were elected *Ex-officio Fellows*:—

Germany.—K. Preussische Akademie der Wissenschaften zu Berlin. (Dresden) K. Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher. (München) K. Bayerische Akademie der Wissenschaften.

Austria-Hungary.—(Wien) K. Akademie der Wissenschaften (Prag) K. Böhmische Gesellschaft der Wissenschaften. (Budapest) Hungarian Academy.

Holland.—(Amsterdam) K. Akademie van Wetenschappen.

Denmark.—(Kjöbenhavn) K. Danske Videnskabernes Selskab.

Sweden.—(Stockholm) K. Svenska Vetenskaps-Akademien.

Switzerland.—(Zürich) Allgemeine Schweizerische Gesellschaft für die Gesammten Naturwissenschaften (Société Helvétique des Sciences Naturelles).

France.—(Paris) Académie des Sciences.

Belgium.—(Bruxelles) Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique.

Italy.—(Roma) R. Accademia dei Lincei.

Portugal.—Academia R. das Sciencias de Lisboa.

Russia.—Académie Impériale des Sciences de St. Pétersbourg.

The Ordinary Wednesday Evening Meeting in the Library, on the 18th June, was very numerously attended, to hear Professor Abbe give a demonstration of his "Theory of the Microscope and nature of Microscopic Vision," by the aid of the special apparatus belonging to the University of Jena, devised by him for the purpose.

The apparatus consists of an objective of about 1 foot focal length, with a condenser of the same power, the illuminating beam from the lamp being in the focal point of the latter, so that parallel rays fall on the objects exhibited, which consist of gratings of various forms ruled on plates of glass coated with a very fine film of lampblack. The instrument, in fact, forms a Microscope of unusually low power, and consequent large scale. The sub-stage was designed some years ago, and was the same in principle as that of Mr. Zentmayer of Philadelphia. Some of the most curious of the experiments were produced by the illuminating beam being made to fall with oblique incidence on the gratings by means of the swinging sub-stage.

The Professor explained and illustrated by diagrams on the black-board the essential points of the views he put forward in 1874, as to the manner in which the microscopic image is formed, and the causes of the appearance presented by certain details in the image, which he showed to be due to the influence of the internal structural constitution of the object upon the rays of light transmitted through it, the microscopic image of an object with very fine details being in fact composed of two images, an "absorption image" and a "diffraction image," and the ordinary theory that explained the formation of the image by the geometrical method, and attributed the action of wide-angled glasses to shadow effects, being altogether fallacious. He showed the production of spurious lines, hexagons, &c., in the same object, when different diaphragms were used, and gave other interesting demonstrations of his theory, with a perfection (by means of the new apparatus) that could not be attained with the ordinary Microscope.

The Professor's views have already been published *in extenso*,* but he added a new demonstration, of which he has promised to write a short explanation for the October number of the Journal.

Scientific Evening.

The second Scientific Evening of the Session was held in the Libraries of King's College, on the evening of Wednesday the 21st May, 1879.

The following were the objects, &c., exhibited:—

Dr. E. W. Alabone:
  Dissection of drone-fly, showing sucking stomach, chyle stomach, tracheal vessels, nervous system, &c.

Mr. F. W. Andrews:
  Crystals from the surface of an ancient terra-cotta Etruscan vase, and from a glazed terra-cotta Spanish mosaic of the fifteenth century.

Mr. Charles Baker:
  Model binocular and model histological Microscopes.

Mr. W. A. Bevington:
  Stephenson's erecting Microscope.
  Lung of frog.

Mr. Arthur Cole:
  A series of 24 slides of aromatic salts for the polariscope, prepared by Dr. Otto N. Witt.

Mr. Frank Crisp:
  Melicerta tubicolaria.
  Trachelius ovum.

* See 'Arch. Mikr. Anat.' (Max Schulze), ix. (1874). "Contribution to the Theory of the Microscope," translated by Dr. H. E. Fripp in the 'Proceedings of the Bristol Naturalists' Society,' n. s., i. (1875) p. 200, and extracted in part in 'M. M. J.,' xiv. (1875) pp. 191 and 245. See also Mr. J. W. Stephenson's paper, "Observations on Prof. Abbe's Experiments illustrating his Theory of Microscopic Vision," in 'M. M. J.,' xvii. (1877) p. 82 (1 plate), and Mr. Crisp's "On the Influence of Diffraction in Microscopic Vision," 'Journ. Quek. Micr. Club,' v. (1878) p. 79 (1 plate).

Mr. Charles Dunning:
Limnoria terebrans, and *Chelma terebrans*.
Mr. Frederick Fitch:
Œsophagus of blow-fly, showing constrictions.
Mr. Edward George:
Spores and elaters of *Targionia Michelii*, *Fossombronia pusilla*, *Aneura pinguis*, and other Hepaticæ.
Mr. A. de Souza Guimaraens:
Tooth of *Dendrodus*.
Arborescent crystals in glass.
Mr. Henry F. Hailes:
Foraminifera from Port Adelaide.
Messrs. How:
Trachyte, Hypersthenite from Penig in Saxony, and Chert from the Middle Drift near Wood Green.
Mr. W. T. Loy:
Series of dissections illustrating the anatomy of *Meloë cicatricosus* and larva of *Bombyx mori* with dorsal vessels injected.
Mr. J. Mayall, jun.:
Abbe's apertometer, with Powell and Lealand's and Zeiss's oil-immersion objectives.
Mr. A. D. Michael:
Nothrus theleproctus, one of the Oribatidæ, and the newly discovered nymph of *Tegeocranus latus*.
Dr. J. Millar:
An undescribed boring sponge.
Mr. E. T. Newton:
Sections of brain of *Blatta*.
Model of insect's brain.
Messrs. Powell and Lealand:
$\frac{1}{8}$ oil-immersion objective.
Mr. B. W. Priest:
Marine alga—*Wrangelia multifida*.
Mr. Henry J. Roper:
Fungi—*Peridermium pini* and *Aecidium aviculare*.
Mr. Walter W. Reeves:
Fresh-water Algæ—*Bulbochæte setigera* and *B. pygmæa*.
Mr. Charles Stewart:
Section, stained, of bud of *Fraxinus excelsior* and the growing-point of *Chara*.
Mr. J. W. Stephenson:
A Salpa—prepared with $\frac{1}{8}$ per cent. of osmic acid.
Mr. Amos Topping:
Mouth of tadpole.
Tongue of garden spider.
Mr. F. H. Ward:
New micro-spectroscope.
Series of sections of plant-stems stained.

Walter W. Reeves,
Assist.-Secretary.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER, 1879.

TRANSACTIONS OF THE SOCIETY.

XXX.—*On a New Species of Cothurnia.* By John Davis, F.R.M.S.

(*Read* 14*th May*, 1879.)

Plate XX.

On recently examining some sea-water, I discovered a colony of Infusoria, which for brilliancy of colour and peculiarity of form, differ, I think, from any species hitherto described.

The water was taken from the "sea-horse" tank in the vestibule of the Brighton Aquarium (by the kind permission of Mr. Lawler, the tank manager). The animals were attached to Confervæ which had been growing on the rocks for about three years, and some small twigs placed there for the Hippocampi were completely covered with them. They undoubtedly belong to the genus *Cothurnia.*

The lorica is generally indistinctly divided into three or four transverse segments, or rings, and is attached by a pedicle to the Confervæ. It is apparently horny, and is of a bright orange colour, but with a condensed, side, light inclines to a yellowish brown, similar to the colour observed on the tube of *Melicerta ringens.* This colour is deeper at the lower end of the tube, and becomes gradually fainter towards the distal extremity, where scarcely any trace of colour is seen.

EXPLANATION OF PLATE XX.

Fig. 1.—Animal protruded. *a a*, forked setæ. *b*, operculum. *c*, outer wreath of cilia. *d d*, contractile vesicles. *e*, unknown organ. *f*, clear space. *g*, posterior processes. *h*, strengthening band. *j*, prolongations of footstalk. *k*, central wreath of cilia.

Fig. 2.—Animal contracted. *a*, operculum. *b b*, contractile vesicles. *c*, unknown organ. *d*, muscular bands beneath the operculum.

Fig. 3.—Individual with young attached. *a*, unknown organ. *b*, free end. *c*, contractile vesicle. *d*, egg-like bodies. *e f*, contractile vesicles. *g*, unknown organ.

Fig. 4.—Young animal. *a*, wreath of cilia. *b*, end of lorica.

Fig. 5.—Young animal. *a*, rudimentary operculum. *b*, body of adult. *c*, end of lorica, *d*, unknown organ.

In some individuals the segmentation can be distinctly seen, but in others it appears merely as a slight corrugation. The lowest segment is much larger and broader than the others.

By means of carmine, I was able to impart a brilliant hue, not only to the tube, but to the pedicle, and I then saw for the first time small Infusoria attached to the surface of the lorica and pedicle.

The free extremity of the animal, when it is extended, is of an oval form, hardly as long or as broad as the aperture of the lorica. At one end is placed an operculum, so that when the body is contracted it closes the narrow part of the neck of the lorica (see Fig. 2). In the centre there is a round protuberance, which appears to be of the same substance as the lorica.

This extremity much resembles that described by Mr. F. W. Hutton.* Its flat surface is placed transversely to the mouth of the lorica, and it is furnished with two strong cilia, or setæ, which are forked at about half their length. Besides these there are a number of much finer cilia arranged round the margin, and in the centre is a wreath of very minute cilia in constant motion.

The forked appendages and long marginal cilia move with a spasmodic jerk, and are very irregular in their action; they do not cause a vortex in the water like the central cilia.

In the anterior part of the animal are two contractile vesicles. No eye-spots were apparent.

The body, when extended, is spindle-shaped; containing granules of various shades from a pale yellow to a dark green, amongst which are a number of vacuoles. Towards the posterior extremity the body is of a dark sepia tint, but contains a light-coloured and rather large spot.

When the animal is extended it is much smaller than the lorica, but when contracted it fills the lower portion of it, as shown in Fig. 2. At the lower extremity of the tube the horny substance doubles on itself and forms a band running round the margin of the body; from which project two processes growing parallel with the pedicle. They show no signs of structure.

The footstalk is $1\frac{1}{2}$ times the length of the lorica in the adult. It is composed of a much more horny substance, as I find it always bent abruptly, forming an angle. The proximal end of the stalk is slightly expanded, and throws out a number of prolongations of various lengths, some going half round the Confervæ. I did not observe the animal at any time contract its stalk, or in fact exhibit any movement in this part.

The animals appear to possess a great amount of sensitiveness to external influences. Sometimes by darkening the stage or by the slightest movement they will instantly contract, and will not

* This Journal, i. (1878) p. 49.

fully protrude for some time, which makes them very difficult to examine. They are all solitary and very sluggish. I have never been able to cause them to imbibe coloured matter.

Size, about $\frac{1}{200}$ of an inch, including the footstalk, when full grown.

Fig. 3 shows a young animal growing on the lorica of an adult; no trace of an operculum could be seen in this individual. Fig. 5 shows the first appearance of an operculum in a rudimentary form, seven hours afterwards. The young are always colourless and transparent, and show no signs of corrugation of their loricæ.

Fig. 4 is the appearance of the distal end of the young animal eight hours after that in Fig. 3, showing a wreath of cilia.

If this species is new, I propose calling it *Cothurnia corrugata.*

XXXI.—*On some Causes of Brownian Movements.*

By William M. Ord, M.D. Lond., F.R.M.S., &c.

(*Read* 11*th June*, 1879.)

The following communication embodies the results of experimental observations on those movements of minute particles in fluids which are commonly called "Brownian." I prefer retaining this name for them in spite of the existence of the old term, "molecular," and of such terms as "titubation" and "pedesis," since, while no hypothesis is asserted, everyone at once knows what is meant when Brownian movements are spoken of, and, what is of no little importance, the term is extensively used on the Continent.

The first experiments to be noticed were made with emulsions of oil and albumen, and were suggested by phenomena observed during the repetition of Ascherson's experiments. Ascherson, as is well known to physiologists, demonstrated * that, when oil and albuminous fluid are brought into contact with each other, a tough, elastic film, the "haptogen membrane," is formed between them; and that when the oil and albumen are shaken together so as to form an emulsion, every globule of oil is instantly surrounded with a delicate pellicle, which he called a "cell-membrane." The experiment is of course easily repeated. And then it is always seen that the oil-drops are surrounded each by a thin coat of albuminous matter, which prevents them from fusing with each other, as oil-drops fuse after oil has been shaken with water or with alkaline solutions. We see the condition which exists in yolk of eggs and in milk. Under high powers of the Microscope the albumen-invested oil-drops are found to be in constant movement.

Experiment:—Some egg-albumen is well shaken with thirty parts of distilled water, and the solution is cleared by filtration. Being now mixed with an equal bulk of olive oil, it is shaken till a persistent emulsion is obtained. This, under magnifying powers of 400 to 700, is found to be composed of tiny globules of oil suspended in the albuminous fluid. The globules vibrate ceaselessly, bodies approaching in their diameter the red blood-corpuscles of man setting to one another in a vague and irregular dance with as much activity as if they were the finest molecules of indian ink or gamboge suspended in water. After a time the movements slacken as the globules float to the surface, and apply themselves to the covering glass; and when at length they stick to it they lie still, just as Dr. Bastian has shown that particles of heavy matter, such as baric sulphate, sink to the bottom of the fluid and lose their molecular motion. The point of interest in the observation is that the movements are here manifested in masses of measurable size. It may be that their shape allows more readily of free mobility;

* Müller's 'Archiv,' 1840.

but there is a further possible explanation in the fact that chemical activities are at work. The instantaneous formation of the membrane indicates the existence of a decided chemical interaction between the oil and the albuminous solution, and to the persistence of this interaction as producing effects of surface tension I am inclined to attribute the agitation of such comparatively large granules. The method of observation here employed allows of the introduction of new and varied conditions by which the induction may be tested. And by employing such tests I am able to show that the movements are more active and more persistent in proportion as conditions prevail, which favour the activity of chemical changes in the fluid, or of reactions between the fluid and the oil; and, conversely, that the movements are diminished or altogether stayed by the introduction of conditions which hinder such chemical reactions. I may state what I have obtained in three lines of research, namely,—

(1) As to the influence of concentration and dilution of the albuminous suspending fluid;

(2) as to the influence of alkalies;

(3) as to the influence of acids.

1. In emulsions made with equal bulks of oil and of albuminous fluid of various dilution I have found great differences of activity of movement. With undiluted fresh white of egg the emulsion is very perfect, but the movements are sluggish or almost imperceptible. On dilution of the albumen the movements increase in vivacity until thirty or forty parts of water are added, beyond which dilution leads to enfeeblement of movement.

2. When a little liquor potassæ or carbonate of potash is added to the albuminous liquid before mixture of the latter with the oil, an emulsion of great fineness may be obtained by a single shake of the containing vessel. After a good shaking the fluid is found loaded with molecules of the smallest size mixed with a smaller number of granules and globules of all diameters up to that of half a blood-corpuscle. The movements of these molecules are remarkable as respects both range and quickness. If some of the emulsion produced by a single shake be compared with the above, the proportion of the smallest molecules is much less, and the globules are larger, but even here globules as large as a blood-corpuscle are seen moving with great freedom. When the smaller molecules are in great excess, as in the first case, the movements of the larger might possibly be produced by the blows of their innumerable satellites, but where the larger are in excess their movements must, I think, be considered as belonging to themselves.

3. If, while an emulsion of oil and albuminous fluid with or without alkali is under the Microscope, a drop of strong acetic or of hydrochloric acid be allowed to run under the covering glass, a

momentary precipitation of albuminate is followed by solution in excess of acid. Then the small molecules disappear to a large extent. But the larger remain, and are motionless.

If, again, a solution of acid-albumen be prepared in any way (as by warming fresh albumen with dilute hydrochloric acid, or by digesting dried albumen or dried alkali-albumen with dilute hydrochloric acid) and be well shaken with an equal bulk of oil, an emulsion is formed, but with difficulty, and with no approach to the completeness of the alkaline emulsion.

The particles of this emulsion manifest tolerably active and persistent movement. But the addition of strong hydrochloric acid, which is in this case not attended with any precipitation of albumen, almost entirely stays all movement, in many cases arrests it completely. In this respect my experience is the same as that of Professor Jevons, who finds that molecular movement is hindered by acids.

Such emulsions left in test-tubes for some time show very interesting microscopical phenomena. An alkaline emulsion, made with neat's-foot oil, examined at the end of sixteen days, had a thick, white cream on the surface, the fluid beneath remaining of a pale, thin sky-blue.

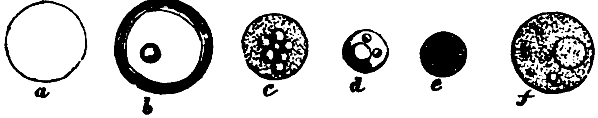
The cream consisted of a mixture of minute and most vivacious molecules with larger spherules—as much as $\frac{1}{1000}$ or $\frac{1}{800}$ inch in diameter. They had thick walls, often sharply laminated, and contained either clear fluid, or one or more oil-globules floating in clear fluid, or a dense cloud of vibrating molecules of the smallest size, or, lastly, smaller vesicles enclosing globules or molecules pill-box-fashion. The conditions here at work were, apparently, 1st, an expansion of the haptogen membrane of spherical globules by osmose; 2nd, a continuous addition to the surface of the membrane; 3rd, a repetition of the original membrane-forming action, following the contact of ingoing soluble alkali-albumen with the contained oil, or solution of the oil by the alkali. In the acid-albumen (syntonin) emulsion the smallest molecules had mostly disappeared by the end of sixteen days; the general movements were sluggish and slight. Laminated vesicles of large size abounded (see Figs. 1 and 2).

Comparing these emulsion experiments with those observations in which particles of gamboge, indian ink, or china-clay, are suspended in a chemically indifferent fluid, such as pure water, the introduction of at least two new sources of movement may be contended for. 1st, the chemical surface tension already noticed; 2nd, vibrations or intestinal disturbances in the colloid suspending fluid, such as attend its decomposition, or its metamorphosis, or its resolution into a crystalloid.

As regards the first, the formation of an emulsion is most perfect, and the movements of molecules are most active, when the chemical action between the oil and the albuminous solution is most active. The acid-albumen, the simple egg-albumen, and the

alkali-albumen manifest three well-marked degrees of combining affinity for the oil, with which as many well-marked degrees of emulgence and molecular vibration correspond. The movements are produced or hindered by the same class of relations which

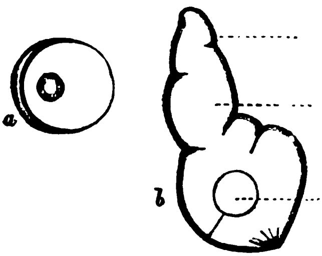
FIG. 1.



a, Simple vesicle, containing clear, not oily contents.
b, Cell with laminated walls containing oil-globule floating in aqueous fluid.
c, *d*, *e*, Vesicles containing emulsions of various fineness.
f, Vesicle containing a smaller vesicle with emulsion.

cause a piece of paper soaked in alcohol to move with violent jerks and in all directions when thrown upon a surface of water, or allow a piece of paper soaked in paraffin to float quietly with a simple linear movement to the margin determined by the attraction of the containing vessel.

FIG. 2.



a, Laminated cell, thin on one side as most are, containing oil-globule floating in aqueous fluid.
b, An irregular mass of fat, invested by a membrane, the folds of which are very plainly marked, and containing a vesicle.

As regards the second, the chemical stability or indisposition to decomposition, of the suspending fluid shows well-marked grades in the several experiments.

a. We find that egg-albumen is unfavourable to active movement in proportion to its viscosity. What may be the exact meaning of viscosity cannot be discussed here, but albumen in the viscous state is not prone to rapid decomposition, tending, indeed, when exposed in open vessels not too deep, to dry up without putrefying. This influence of viscosity is well illustrated in condensed milk.

b. Albumen being mixed with water putrefies with a readiness proportioned to its dilution; and it is seen to favour movements in proportion.

c. Alkaline solutions of albumen putrefy more readily than simple solutions. With alkali the movements are quickened.

d. On the other hand, acid-albumens do not putrefy readily. Solutions of syntonin in acid can be kept for a long time, and the durability of peptones is notorious. With acids the movements are hindered in some proportion to the strength or excess of acid.

e. But peptones being neutralized by alkali fall at once into putrefactive changes.

Generally speaking, in all chemistry, acids hinder decomposition, tending to hold water and other matter in a state of tension. Thus we use acids for pickling, in the same way as we use strong neutral saline solutions; that is to say, mixtures of water with substances having a strong attraction for it. In the experiments recorded acids come to check movements by neutralizing alkali, just as Professor Jevons has shown that they arrest Brownian movement when chemically indifferent matters are suspended in pure water. I may say that before the publication of Dr. Jevons' observations I had made many experiments to test the influence of acids, and that my conclusions entirely agree with his. In stating this, I have no intention of derogating from the originality of Professor Jevons, but simply of adding my testimony to his on a matter of some importance. Free alkalies, on the other hand, are everywhere provocative of decompositions and unrest. Beyond what we have noticed, as in peptones, we see alkalies used by the chemist to induce breakings up, oxidations, and the formation of new matters, usually of smaller out of larger molecules. They tend, in fact, to determine the formation of new matters with which they may combine, and so help to favour a tendency which seems to belong to all matter, that of coming to rest.

From these various considerations I venture to draw the inference that minute intestine vibrations of the colloid suspending fluid have a power of intensifying molecular movements in suspended particles.

This is, I submit, greatly favoured by the concomitant variations set forth, showing that the movement of particles is more or less active according to the presence in the surrounding fluid of conditions favouring or hindering chemical changes in the colloid.

I may cite an experiment in which the method of difference gives results in the same direction. One of the best mixtures for demonstrating molecular movement is that of indian-ink with distilled water. The solid ink is rubbed gently with water until a mixture of suitable thickness is obtained. This consists of particles of solid black matter suspended in water now dissolving whatever viscous matter had been used to bind the particles into a cake. What this viscous matter may be I know not exactly, but from all appearance it is some kind of gum—in other words, a colloid.

Now, if a large quantity of indian-ink be rubbed down with water, and the mixture be left in a tall vessel to allow of subsidence of particles, the viscous matter may be in process of time to a large extent washed away, leaving a mixture of particles with nearly pure water. This mixture shows an infinitely less active and persistent movement, though with particles of the same size and number.

The influence of solutions of soap upon Brownian movements, as set forth by Professor Jevons, appears to me to support my contention in the way of agreement. He shows that the introduction

of soap into the suspending fluid quickens and makes more persistent the movements of the suspended particles. Soap in the eyes of Professor Jevons acts conservatively by retaining or not conducting electricity. In my eyes it is a colloid, keeping up movements by revolutionary perturbations. Indeed, soap is a very typical colloid in its tendency to physical change without obvious decomposition. A solution of soap, at first clear and transparent, becomes usually within a few hours thicker to the eye; and as days proceed it becomes thicker and thicker, until it has almost a granular look, though even then nothing is separable by filtration. Curiously enough, the formation of soap is involved in all our emulsion experiments. And I venture to argue that the most interesting applications made by Professor Jevons in relation to the detergent powers of soap illustrate the influence of the colloid in causing rearrangement of particles brought within its sphere of action. It is interesting to remember that, while soap is probably our best detergent, boiled oatmeal is one of its best substitutes. What this may be as a conductor of electricity I do not know, but it certainly is a colloid mixture or solution. With Professor Jevons's idea that the detergent value of soap depends upon its power of causing minute molecular disturbance rather than upon its chemical action, we may compare in support Mr. Rainey's remarkable demonstration of the erosion of the surface of glass slides by spheres of carbonate of lime deposited on the slides in solutions of gum. Here, again, no chemical action is involved, the erosion being a result of attraction exercised upon the molecules of the glass by the molecules of the carbonate sphere, the disturbing influence of the colloid allowing of rearrangement, or, indeed, favouring it by disturbing pre-existing relations of molecules.

In relation to the general subject of my paper, I would argue that the increased movements here visible as a result of the presence of colloids in the suspending fluid, are but larger forms of the movements demonstrated by Mr. Rainey as occurring in crystalloid matters deposited in colloid solutions.

He has shown that colloids interfere with the molecular arrangement of crystals, and compel them to take a spheroidal form—this he calls "molecular coalescence."

He has again shown that spheres formed by molecular coalescence may be broken up on being introduced into colloid solutions of the same nature as that in which they were originally deposited, but of different density. This he calls "molecular disintegration," and this again bears on the detergent value of soap.

Again, the susceptibility of different crystalloids to this sphere-forming power of colloids not being equal, I have shown at various times that the power of colloids to master the polarity of any crystalloid is intensified by whatever tends to increase vibration in

the colloid, e. g. decomposition or heat; or by the existence in one colloid of a higher molecular composition than in another—albumen, for instance, having a greater power, even when coagulated, than gelatin or gum. Conversely, dilution, coagulation, condensation, cold, magnetism, all hinderers of vibration, hinder sphere-formation.

Quite recently I have been able to illustrate these influences by experiments, which show the movements of molecules translated into large movements visible under the Microscope, and in one case visible to the naked eye. These experiments are before another Society and I am not in a position to quote them at present.*

To sum up, therefore, while I admit that heat, electricity, capillary attraction, chemical and other forces may each or all play a part in producing Brownian movements; while I admit the agency of surface-tension; while I do not altogether reject Mr. Rainey's theory of persistent movements in fluids,† I claim the intestine vibration of colloids as in many cases an agent in the process, and more especially in the fluid and semi-fluid parts of animal and vegetable organisms.

Indeed I am disposed to go further, and to regard this as in one aspect a manifestation of a tendency, already glanced at, in all molecules to come to rest—to rest of a physical or chemical kind; and of all molecules of one kind to find rest in association with their kind, as in the crystal. Slow movements of this kind have been at work in the yet pulpy chalk separating the flints from it. Slow movements of the kind are abundantly illustrated in the metamorphoses of minerals. Quicker movements are seen in the mixture of the kaolin and distilled water; quicker still in kaolin with soap. As I see crystalloids struggling in the grasp of colloids, and gradually extricating themselves from their grasp to revert to the crystalline from the spherical form, with constant accompaniment of molecular movements, I see the existence of a chain of force leading from the activity of movement which builds up the sphere to the rest which is possible only to the inorganic crystal, and compare this chain with the chain seen in the vaporization of water by the sun, the lifting of the vapour to the upper regions of the atmosphere, its condensation to cloud, and its subsequent descent in rain or in rivers to rest in the sea. As the one chain produces a series of actions and expenditure of power in the outer world, so in the economy of living organisms some such chain as I have compared with it may well play its part in development, in organization, in motion.

* See a paper since read before the Royal Society (June 19th, 1879), entitled "An account of Experiments on the Influence of Colloids upon Crystalline Form, and on Movements observed in Mixtures of Colloids with Crystalloids."

† See St. Thomas's Hospital Reports, vol. ii. 1871, "On Continued Movements in Fluids."

XXXII.—*Observations suggested by the Study of Amphipleura pellucida, mounted in Canada Balsam, by Lamplight and Sunlight, with various Objectives.* By J. J. Woodward, Surgeon and Brevet Lieutenant-Colonel U.S. Army, Hon. F.R.M.S.

(*Read* 11*th June*, 1879.)

In the latter part of October, 1878, I received from Carl Zeiss, of Jena, two objectives, a $\frac{1}{8}$ and a $\frac{1}{12}$, both "oil-immersion," or as they are now called by their maker, "objectives for homogeneous immersion." To test their performance, I made with them some photographs of *Amphipleura pellucida* mounted in Canada balsam, and, for comparison, photographs of the same frustule, with several other objectives. On January 20, 1879, I wrote to Zeiss a brief account of these experiments, and sent him a set of the photographs, together with a duplicate set for Professor E. Abbe, of Jena. I learn from the Journal * that Professor Abbe promptly sent one set of these photographs, together with my letter, to Mr. J. W. Stephenson, who exhibited the photographs and read parts of the letter at the meeting of the Royal Microscopical Society, February 12, 1879.† This circumstance, which was fully in accordance with permission granted in my letter to make public use both of it and the photographs, would render it unnecessary for me to do more at present than to send duplicates of the photographs for the cabinet of the Society, but that, since writing to Zeiss, I have made photographs of the same test with several other notable objectives, especially a $\frac{1}{8}$ glycerine-immersion by Spencer, and a $\frac{1}{10}$ oil-immersion by Tolles, and that the results induced me to make a new series of comparative photographs with the best objectives at my disposal, including, of course, those of Zeiss. This new series I now send to the Society instead of the original one.

Several matters of interest were first noticed or strikingly illustrated during the progress of the work, and to these it is the object of this paper to draw attention.

I. The first point was brought out during the original series of experiments, and was detailed in my letter to Zeiss, but does not appear to have been read to the Society, viz. the best mode of projecting images upon the screen for photographic purposes with such objectives as those of Zeiss. These objectives, it will be remembered, have no screw-collar adjustment, and their aberrations are completely corrected only when the focal adjustment is such that the image is formed at a fixed distance, which, in the case of the two objectives sent me, is 10 inches. Now, to obtain the

* Vol. ii. (April, 1879) p. 214. † Op. cit., p. 140.

magnifying power I desired for the photographs, from ten to fifteen times this distance is required, and it would at first sight appear necessary for this purpose to bring the objective so much closer to the object than the position for which alone it is corrected, that the resulting aberrations would quite destroy the definition of the image. This difficulty appears to have occurred to Zeiss himself before he sent me his objectives, for he voluntarily furnished with them two concave lenses said to be of 25 and 30 centimetres focal length, which he directed me to screw immediately into the posterior part of the brass mounting of the objectives when I used them for photography, and by which he supposed the aberrations introduced by distance would be corrected. One of these concaves was intended to correct the aberrations when the image was projected to 1·5 or 2 metres distance; the other was expected to answer the same purpose at the distance of 3 metres or upwards.

If Zeiss consulted his distinguished adviser, Professor Abbe, as to the formulæ for these concaves, I do not doubt that he was correctly instructed; but if so, the lenses as actually sent do not correspond very precisely with the mathematical requirements. I tried them faithfully, and wrote to Zeiss as the result of my examination, that when I came to study the images produced with these concaves at the distances directed for each, "I became painfully aware that a curvature of field had been introduced which did not belong to the image as viewed with the 10-inch tube, while great loss of definition indicated the presence of considerable spherical aberration in the new combination." Photographs taken under these circumstances were exceedingly unsatisfactory, and had no other means of projecting images with these objectives been available, I should not have succeeded in presenting a photographic demonstration of their excellent qualities.

But long before I received them I had theoretically devised a method for making these projections, which on trial fully answered my expectations, and gave, at any distance I chose to select, images quite equal in flatness, definition, and brilliancy to the best I could obtain with the 10-inch tube. This method consists in placing a suitable achromatic negative lens at the end of the draw-tube of the Microscope body, and slipping it by trial to the proper position to bring the image to a sharp focus on the screen at the distance selected, while the objective remains in precisely the same focal position that was found to give the best image with the 10-inch tube. The course of the rays through the objective under these circumstances remains the same whether the image is projected to 1 or 4 metres, or any intermediate distance, and, provided the concave has the requisite qualities, the sharpness of the image is unimpaired.

For this purpose I had selected an "amplifier" made for the Museum more than ten years ago by Mr. Tolles, of Boston. It was originally intended to be used at the end of the draw-tube in ordinary microscopic work for the purpose of obtaining increased magnifying power. This "amplifier" was a negative achromatic meniscus of about 6·5 inches virtual focus and ·7 of an inch in diameter. I had in the Museum collection a number of other "amplifiers" specially constructed for the projection of microscopic images, but knew by previous experience that none of them equalled the Tolles amplifier in flatness of field or freedom from spherical aberration. After failure with the Zeiss amplifier, therefore, I tried this Tolles amplifier in the manner I had originally intended, and after some little experiment to ascertain its proper position in the Microscope body for the distances at which I designed to form the images, I obtained the results at which I aimed.

It will readily be understood that the best position of the amplifier with the Zeiss $\frac{1}{8}$ or $\frac{1}{12}$ for the projection of the image to say 10 feet distance from the object, will also be the best position for all other objectives, provided their corrections are best neutralized when they are focussed on the object with the 10-inch tube, and therefore the positions of the draw-tube corresponding to the best images at a series of selected distances having been found by careful experiment with any selected objective, may be used successfully with any other objective corrected for the 10-inch tube. Indeed this method may be advantageously resorted to in the case of objectives provided with a screw collar, in place of the usual method in which the screw collar is used to correct the aberrations introduced by distance. The positions of the amplifier, as indicated by the scale on the draw-tube, having been found for the distances at which the pictures are to be taken, it is only necessary in subsequent work with the same amplifier, to set it, by means of the draw-tube, at the position known to be best for the distance selected, and then to focus with the fine adjustment in the usual way.

It was in this manner that the images were projected for the photographs I sent to Zeiss, and for those which accompany this paper. I am pleased to observe by his printed circular, dated March, 1879, that since he received my letter in which this method was explained, and the photographs sent with it, Zeiss has been influenced by them to construct and advertise for sale a concave lens of 10 or 12 centimetres focus, to be placed at the end of the draw-tube (in das Auszugsrohr des Tubus eingesetzt), for the purpose of projecting images with his objectives, instead of the unsatisfactory device he offered me last fall. I regret to find, however, that I have unintentionally misled Zeiss as to the focal length of the amplifier I used. Copying by accident from my

note-book a memorandum referring to another amplifier, I wrote him that it had a virtual focus of about 12·5 centimetres, whereas its focus is really somewhat more than 16.

I do not, however, doubt in the least that excellent results may be obtained with a properly constructed amplifier of the focal length he has adopted, and can express no opinion as to how far he has succeeded in this direction, because I have not yet seen one of those he is making. But I must point out that it is not enough to have a properly constructed amplifier, and to screw it at the end of the draw-tube; it is also of prime importance that the proper position of the amplifier should be found for the distance selected. If this is neglected, very unsatisfactory results may be obtained with excellent instruments.

I must add, that the plan of using a negative lens behind the objective, for the purpose of increasing the size and flatness of the image formed by a solar or gas Microscope on the screen, is quite an old device, as is also the plan of using a negative lens between the eye-piece and objective (preferably at the end of the draw-tube) for the purpose of increasing the magnifying power of the Microscope. I was, however, the first to point out the advantages of employing a suitable achromatic concave in place of the eye-piece of the Microscope for the purposes of photo-micrography. I had already published a preliminary notice of this method in 1865,* and described it in more detail in 1866.† Since then I have repeatedly, in published articles, in private letters, and by word of mouth insisted upon this point, until it has become so familiar that some of my correspondents imagine it to be their own contrivance. I have not hitherto, however, nor has any other microscopist, to my knowledge, commented upon the important application of the achromatic concave described above, in which, by giving it suitable focal length and position, it is used to project the image upon the screen while the object-glass is in precisely the position with regard to the object that it would occupy in ordinary work, and the course of the rays through it quite the same.

II. The second point to which I wish to call attention relates to the obliquity of the illuminating pencil necessary to resolve difficult lined test objects, such as *Amphipleura pellucida* mounted in Canada balsam, by objectives of adequate aperture. Until a comparatively recent period many respectable microscopists still clung with affection to the singular theoretical error that the angle of aperture of immersion objectives, as measured in a medium (such as Canada balsam) of about the index of refraction of crown

* Circular No. 6, War Department, Surgeon-General's Office, Washington, 1865, p. 149.

† 'American Journal of Science and Arts,' vol. xlii. (1866) p. 189; also 'Quarterly Journal of Microscopical Science,' vol. vi. (1866) p. 166.

glass (it has been the fashion to call it the balsam angle), could by no means exceed double the angle of total reflexion from glass to air, which theory indicated as the limit for dry objectives. It is now universally admitted by the physicists and mathematicians whose attention has been directed to the subject, that this limit, inflexible as it necessarily is for dry objectives, has nothing whatever to do with the question of the aperture of immersion objectives, which indeed, from this point of view, would be limited only by double the angle of total reflexion from glass to the immersion fluid. The adherence of any individual microscopist to the old error is therefore no longer of importance, and the practical opticians, acting in strict accordance with correct theory, have succeeded in constructing water, glycerine, and oil-immersion objectives, not merely exceeding 82°, but attaining 100°, 115°, and even, in the case of one well-known maker, over 120° balsam angle for an oil-immersion objective. The limit of improvement in this direction is not yet attained.

Professor Abbe has recently announced his expectation * that it will be possible in the near future to construct objectives having an aperture of 128° in a medium of 1·50 index of refraction. That this expectation will be realized, and with resulting improvement in defining power, I do not doubt in the least, but cannot believe that the limit will be found even here.

But while the correct views with regard to the aperture question are now generally accepted, and a number of practical opticians are making use of this knowledge in the construction of improved objectives, we hear it continually asserted of late, that no advantage can possibly be derived from the excess of angle in immersion objectives beyond the much-talked-of 82°, unless immersion illuminators are used to throw the illuminating pencil upon the object with an increased obliquity corresponding to the increased angle of the objective.

This statement, which is an exceedingly exaggerated one, has been so loudly reiterated, and has been accepted, without special investigation, in such high quarters, that I have thought it worth while to take this opportunity of drawing attention to the actual facts. It is quite true that when a feeble source of illumination, such as a coal-oil lamp, is employed, it is necessary to use an immersion illuminator by which the light can be thrown upon the object more obliquely than would otherwise be possible, whenever we desire to obtain the best possible resolution of difficult lined test objects with objectives whose balsam angle exceeds 82°. It is also true that the performance of these objectives on histological and

* 'Ueber Stephenson's System der homogenen Immersion bei Mikroskop-Objectiven,' "Sitzungsberichte der Jenaischen Gesellschaft für Medicin und Naturwissenschaft," Jan. 10, 1879.

other preparations, when the illumination is effected by means of a central pencil of light from a coal-oil lamp, is much improved if an immersion condenser of aperture equal to that of the objective be substituted for the ordinary dry achromatic condenser.

But notwithstanding these notable and practically important facts, it is nevertheless equally true that without these valuable accessories the new immersion objectives greatly excel any dry objectives in defining power, both by oblique and central light, provided only that the objects examined are mounted in Canada balsam, or if dry, are adherent to the under surface of the glass cover. Under the same circumstances also, immersion objectives whose balsam angle exceeds 100°, excel in definition immersion objectives of smaller angle. Thus, several of the immersion objectives in the Museum collection which have an aperture greater than 100° balsam, will resolve the 19th band of the Nobert's plate by lamplight thrown obliquely upon the under surface of the slide by an ordinary small bull's-eye condenser, a feat which no immersion objective of smaller angle, and no dry objective, can be made to perform; and the superiority of the definition of these wide-angled objectives, when used to examine histological preparations, bacteria, and the like, illuminated with central light, by the ordinary dry achromatic condenser, is readily recognizable by the practised eye.

These easily verified observations are quite in accordance with the accepted theory of microscopical vision. It has long been practically known, in the case of dry objectives, that those of great aperture exhibit to a marked degree the superior defining power thence resulting, even when the object is illuminated with perfectly central light; and the well-known theoretical explanation of this phenomenon is equally applicable to the case of immersion objectives so long as no film of air intervenes between the object and the front of the objective.

But the superior defining power of wide-angled immersion objectives, when illuminated by central or moderately oblique light, is still more manifest when monochromatic sunlight is employed; and this fact is strikingly illustrated by the photographs which accompany the present paper. A converging pencil of monochromatic sunlight, obtained by a 3-inch objective of about 12° aperture, with its optical axis inclined at an angle of but 45° to the optical axis of the Microscope, will be found quite oblique enough to give magnificent resolution of *Amphipleura pellucida* mounted in Canada balsam, without the use of any immersion illuminator, although in this case it is evident that in consequence of refraction at the under surface of the glass slide, the axis of the illuminating pencil actually impinges upon the frustule at an angle of little more than 27° to the optical axis of the Microscope. If, now, with the illuminating pencil rigidly limited to this angle, a selected frustule

of *Amphipleura pellucida* in balsam be examined successively by a series of immersion objectives, the superior definition of those of greater angle will be readily observed by the eye, and if photographs are taken, will be equally manifest in them.

In the series of photographs of *Amphipleura pellucida* that accompany this paper, those numbered from 1 to 11 were all taken with the angle of the illuminating pencil just mentioned, and will serve to illustrate the accuracy of the statement made. The explanation is quite obvious, for with sunlight the diffraction pencils that radiate from the transparent spaces in the frustule are of sufficient brilliancy to form a very conspicuous part of the image, if brought to a focus by the objective; and just what part of these pencils shall actually be brought to a focus as part of the image, depends in each case upon the aperture of the objective and not upon the obliquity of the illuminating pencil. On the other hand, by lamplight these diffraction pencils are so much less brilliant that they are inadequate to secure resolution, and it is necessary for this purpose to use much more oblique illumination than will answer the purpose by sunlight.

In view of the foregoing considerations, it is not surprising that, in the case of monochromatic sunlight, an increase of the obliquity of the illuminating pencil produces no such marked improvement in the performance of the objective as occurs under the same circumstances by lamplight. To illustrate this fact I have added the photographs numbered 12 and 13, representing the same frustule, as seen by means of an immersion illuminator, with the most oblique light that could be used with each objective without distorting the image. A comparison of these pictures with those taken by the same objectives with the smaller angle of illumination, shows that the improvement resulting from the increased obliquity is very trifling indeed. These pictures will serve to illustrate the general statement that with illumination by monochromatic sunlight, and consequently for the purposes of photo-micrography, the superior definition of objectives of greater balsam angle than 82° is independent of any excessive obliquity in the illuminating pencil, and of the use of immersion illuminators. Indeed, as I shall take occasion to illustrate hereafter by photographs, it is almost quite as manifest with histological preparations and central light as with lined test objects and oblique light.

III. Of the photographs which accompany this paper, Nos. 1 to 13 inclusive are representations of a frustule of *Amphipleura pellucida* from a slide mounted in the Hull Botanical Gardens in 1859. This slide was given to Mr. Wm. A. Sullivant, of Columbus, Ohio, and by him presented to me in May, 1867. As it came into my possession it was a dry mount with the frustules adherent to the cover; but for the purposes of these experiments I

have remounted it in Canada balsam. Of course the difficulty of resolving so delicate an object as *Amphipleura pellucida* is somewhat increased by mounting it in Canada balsam. In January, 1852, Professor Bailey, of West Point, writing to Matthew Marshall, Esq., of the surprising performance of the wide-angled dry lenses just constructed for him by Charles Spencer, declared, "In all these cases (and, in fact, whenever I allude to a test object) I mean the *balsam*-mounted specimens. The dry shells I *never* use as tests." It is amusing at the present day to note how "extraordinary" this assertion then appeared to one of the most distinguished English microscopists, who contrived then, as he has more than once subsequently done, to misunderstand completely the reasoning of the "American opticians," and who boldly wrote, "I have invariably found that when very difficult tests are mounted in balsam I cannot discover the markings." *

At the present day the value of difficult test objects mounted in Canada balsam is more correctly appreciated; and among these one of the most convenient and useful is *Amphipleura pellucida.* It is not many years since this diatom, even when mounted dry, was regarded as one of the most difficult tests. Messrs. Harrison and Sollitt indeed appear to have glimpsed the striæ on the dry mount as early as 1854; but can only have glimpsed them, for they estimated the number at 120 to 130 in the $\frac{1}{1000}$ of an inch, an estimate to which Mr. Sollitt stoutly adhered as late as 1860.† Most other microscopists were unable to verify these observations. Messrs. Sullivant and Wormley ‡ declared that they had "not been able to 'glimpse' the striæ on this diatom." And when Mr. Sullivant sent me the Hull slide he had still been unable to resolve it, as indeed was true of almost all microscopists at that date.

So far as I have been able to learn, Messrs. Powell and Lealand were the first who succeeded in resolving the dry frustules with sufficient distinctness to get correct notions of the fineness of the markings. We learn by a note from Mr. Lobb, dated January 12, 1870,§ that those gentlemen had at that time succeeded in resolving *Amphipleura pellucida* with their immersion $\frac{1}{8}$, $\frac{1}{12}$, and $\frac{1}{16}$, and estimated them at 100 to the $\frac{1}{1000}$ of an inch. I myself first succeeded in resolving and photographing this diatom in January, 1871, and it was a Powell and Lealand immersion $\frac{1}{16}$ that did the work. In a memorandum published by the Surgeon-General's Office, February 1, 1871 (and republished in the 'American Journal of Science and Arts,' vol. i. (1871) p. 345), I stated that I found the striæ on medium-sized frustules counted from 90 to 93 to the $\frac{1}{1000}$ of an

* See 'Quarterly Journal of Microscopical Science,' vol. ii. (1854) p. 214.
† Ibid., vol. viii. (1860) p. 48.
‡ "On the Measurement of the Striæ of Diatoms," the 'American Journal of Science and Arts,' vol. xxvii. (1859) p. 250.
§ 'Monthly Microscopical Journal,' vol. iii. (1870) p. 104.

inch. I found no example in which the number of striæ exceeded 100 to the $\frac{1}{1000}$ of an inch. Since then I have examined a considerable number of *Amphipleura* slides, and only occasionally found one still finer. The finest I have ever counted had 107 striæ to the $\frac{1}{1000}$ of an inch. Ever since January, 1871, *Amphipleura pellucida* has been one of my favourite test objects for immersion objectives. In June, 1871, I succeeded in resolving it by an immersion $\frac{1}{8}$ of Tolles,* and in March, 1872, in connection with its resolution by certain objectives made by R. and J. Beck, and by William Wale, I wrote:—"This diatom is a useful and valuable test for immersion objectives of $\frac{1}{8}$ inch focal length or less. Lower powers can only hope to resolve it if possessed of excessive angular aperture." †

Meanwhile, although I constantly wrote and spoke of the dry frustule, because it gave more brilliant images as I then handled the test, I had already, in January, 1871, resolved with the immersion $\frac{1}{16}$ of Powell and Lealand, several balsam-mounted slides of the same diatom, which Mr. Sullivant had kindly sent me. In February, 1871, Count Castracane wrote from Rome to the Royal Microscopical Society,‡ that the year before he had succeeded in obtaining a photograph of *Amphipleura pellucida* on a Möller's test-plate, balsam mounted, first with a Hartnack immersion No. 10, and afterwards with an objective of the same number by Nachet. The degree of success attained by this distinguished microscopist may be inferred from his own frank acknowledgment:—"Unfortunately my negative was blurred and rather faintish, so that it could not give good positive images. Nevertheless, the striæ are there so finely and so distinctly drawn out, that they may be perceived clearly enough, though the magnifying power of the Microscope was not higher than 640 diameters." § I myself in March, 1872, wrote in a general way of the resolution of the balsam-mounts:—"I may add that any of these objectives, including the Beck's $\frac{1}{10}$, will resolve *Amphipleura pellucida* in balsam, as in fact was done by Count Castracane, with objectives by Hartnack and Nachet." ‖

But all this was by monochromatic sunlight, and it was not until I began to use immersion illuminators with objectives of more than 82° balsam angle, that I succeeded in obtaining satisfactory resolution of the balsam-mounted frustules illuminated with an ordinary coal-oil lamp. Even then it was by no means with every immersion objective of sufficient aperture that satisfactory resolution could be obtained; but during the last six years the number of

* See 'Monthly Microscopical Journal,' vol. vi. (1871) p. 150.
† Same Journal, vol. vii. (1872) p. 166.
‡ Same Journal, vol. v. (1871) p. 176.
§ *Loc. cit.*
‖ Same Journal, vol. vii. (1872) p. 233.

objectives capable of resolving this test has been constantly increasing, and the sharpness of the images produced by the very best objectives has continually improved, until at the present day I have no hesitation in making the assertion that any first-rate immersion objective, even those of as low power as the $\frac{1}{4}$, ought to be able to give distinct resolution of the most finely marked frustules of *Amphipleura pellucida* mounted in Canada balsam. Those incapable of this performance must be classed among second-rate objectives, and will not willingly be employed in serious investigations by instructed microscopists. As for the appearance of balsam-mounted frustules of this diatom by sunlight, under the best modern immersion objectives, it not only rivals in vigour and contrast the finest views of the dry frustules, but greatly excels the best that can be done with these in simultaneous exhibition of the details of outline and midrib.

The frustule on the Hull slide selected for photographic representation in connection with this paper is ·0037 of an inch long, and has 102 striæ to the thousandth of an inch. At the distance of ·0011 of an inch from it, and nearly parallel to it, on the slide is a second rather more coarsely marked frustule, the appearance of which in the pictures will aid in forming a judgment of the flatness of field in each case. Near one extremity of the selected frustule appears the end of another that may be used for the same purpose, while near its other extremity the end of yet another frustule is seen, at right angles to it, which, from its position in relation to the light, is not resolved, although longitudinal diffraction lines appear upon its surface in all the pictures.

All the immersion objectives belonging to the collection of the Museum will show the striæ on the selected frustule by monochromatic sunlight; but some of them, from curvature of field and feebleness of definition, would have given but sorry pictures. I have only thought it worth while to make photographs with a few of the very best of the water-immersion objectives at my disposal, and with certain glycerine and oil-immersion objectives. The following is a list of the photographs, to which I have added a memorandum of the aperture of each objective, as measured with an instrument I have devised, a modification of the apertometer of Abbe, which I will describe fully in a separate paper. The angles are all computed for an ideal medium of 1·5 index of refraction.

(*a*) *Photographs of* AMPHIPLEURA PELLUCIDA, *illuminated by monochromatic sunlight. Condenser a 3-inch objective of* 12° *air aperture inclined at an angle of* 45° *to the optical axis of the Microscope.*

No. 1. Oil-immersion $\frac{1}{18}$, aperture 114°, by Zeiss, vignetted print. 2830 diameters.

No. 2. By the same objective; print not vignetted. 2760 diameters.

No. 3. Oil-immersion $\frac{1}{8}$, aperture 115°, by Zeiss. 2700 diameters.

No. 4. Oil-immersion $\frac{1}{10}$, aperture 122°, by Tolles. 2700 diameters.

No. 5. Glycerine-immersion $\frac{1}{10}$, aperture 105°, by Spencer. 2830 diameters.
No. 6. Glycerine-immersion $\frac{1}{6}$, aperture 106°, by Spencer. 1900 diameters.
No. 7. Enlarged from the last negative to 2760 diameters.
No. 8. Water-immersion $\frac{1}{18}$, aperture 91°, by Tolles. 2760 diameters.
No. 9. Water-immersion $\frac{1}{8}$, aperture 105°, by Powell and Lealand. 2700 diameters.
No. 10. Water-immersion $\frac{1}{16}$, aperture 103°, by Powell and Lealand. 2700 diameters.
No. 11. Water-immersion $\frac{1}{25}$, aperture 91°, by Powell and Lealand. 2900 diameters.

(*b*) *Photographs of* AMPHIPLEURA PELLUCIDA, *illuminated by monochromatic sunlight, with an immersion illuminator and the utmost obliquity each objective would admit without distortion.*

No. 12. Zeiss' oil-immersion $\frac{1}{12}$ (same as No. 1). 2830 diameters.
No. 13. Tolles' oil-immersion $\frac{1}{10}$ (same as No. 4). 2760 diameters.

From my examination of these objectives, I am constrained to give the Zeiss $\frac{1}{12}$ the preference, both by lamplight and sunlight, over all the others named, and, indeed, I may add, over all the objectives I have ever yet examined.

Next comes a group embracing the oil-immersion $\frac{1}{10}$ by Tolles, the glycerine-immersion $\frac{1}{6}$ and $\frac{1}{10}$ by Spencer, and the oil-immersion $\frac{1}{8}$ by Zeiss. All these objectives perform very well indeed. When I wrote to Zeiss last January, I expressed the opinion that the performance of his $\frac{1}{8}$ fully equalled that "of the best of the large collection of immersion objectives belonging to the Museum." But subsequent trial convinced me that my first photographic work with the Spencer's $\frac{1}{10}$ had not done it justice, and I afterwards received the $\frac{1}{6}$ from the same maker and the oil-immersion $\frac{1}{10}$ by Tolles. After protracted trials, I now regard these three objectives as superior in defining power to the Zeiss $\frac{1}{8}$. How they compare with it, and with each other, may be fairly judged from the photographs. Of the water-immersion objectives, the Tolles $\frac{1}{18}$ stands first in my estimation; the Powell and Lealand objectives next.

Among other points suggested by a study of these photographs is the fact that the superiority of the glycerine and oil-immersion objectives is not a mere consequence of their great aperture. The aperture of the $\frac{1}{6}$ of Spencer exceeds but little, and the $\frac{1}{10}$ not at all, that of the $\frac{1}{8}$ of Powell and Lealand, yet their performance is much better. The aperture of the Zeiss $\frac{1}{12}$ is actually less than that of the Tolles $\frac{1}{10}$, which, however, it excels in performance, and a similar comparison may be made between the Tolles $\frac{1}{18}$ and the Powell and Lealand objectives. And yet I do not doubt in the least that each additional degree of interior angle above 82° is a material advantage, provided always that the aberrations of the objective are accurately corrected; but inferiority in the formula employed or in the skill and care exercised in construction may more than neutralize the advantages that ought to be derived from this source. Nor do I doubt in the least the

superiority in a general way of glycerine as the immersion fluid over water, or of oil of cedarwood and other liquids closely approximating crown glass in refraction and dispersion over glycerine. But this superiority does not occur merely because increased angle is thus rendered possible. In fact, as the angle of total reflexion from crown glass to water is rather more than 60°, it is by no means theoretically impossible to construct water-immersion objectives with angle as great as the oil-immersion objectives of Zeiss, or the glycerine-immersion objectives of Spencer. The difficulty in this case is to correct the aberrations which are inevitably produced by refraction at the upper surface of the thin glass cover and the flat surface of the objective front. These aberrations are entirely absent when the immersion fluid has the same refraction and dispersion as the glass on each side of it; are comparatively slight in the case of glycerine; much more considerable with water, and greatest in the case of the dry objectives. Professor Abbe, in the paper already cited, has drawn attention to this circumstance, which appears to me even more important than the fact that with homogeneous immersion there is no loss of light by reflexion at the front surface of the objective, and with glycerine immersion very little; but this also must have its influence.

Taking all the circumstances into consideration, I am disposed to expect further improvement in objectives in the direction of homogeneous immersion rather than glycerine immersion. In the case of homogeneous immersion, too, we have the great advantage of being able to dispense with the screw collar for cover correction, and all the deplorable loss of time entailed by the use of that contrivance, which is absolutely required in the case of glycerine and water-immersion objectives.

For this reason, in my ordinary work I give my Zeiss $\frac{1}{8}$ the preference over the objectives I have named as somewhat surpassing it in defining power; because it gives instantly results that are not far inferior to the best I can obtain from the others with much pains and loss of time.

Finally, to illustrate the superb performance of the Zeiss $\frac{1}{12}$ on dry *Amphipleura*, I have added to the series a photograph (No. 14) of a very delicate frustule on a slide of *Amphipleura pellucida* from the Bridge of Allan, Scotland, mounted by my friend Professor Hamilton L. Smith, of Geneva, New York. This frustule is only 29 ten-thousandths of an inch long, and has 105 striæ to the thousandth of an inch. It is magnified 3400 diameters.

XXXIII.—*Note on Abbe's Experiment on Pleurosigma angulatum.*

By J. J. Woodward, Surgeon and Brevet Lieutenant-Colonel, U.S. Army, Hon. F.R.M.S.

(*Read* 11*th June*, 1879.)

I send herewith two photographs of *Pleurosigma angulatum* taken by the Zeiss oil-immersion $\frac{1}{8}$ and a Tolles amplifier. The magnifying power is 1850 diameters. The one exhibits the markings as ordinarily seen and described; the other, taken with oblique light and a stop, furnished for the purpose by Zeiss, behind the back lens, exhibits the fine diffraction lines parallel to the midrib, described by Professor Abbe, of Jena.

The notable point about this second picture is that the diffraction lines, instead of being limited to the part of the frustule which is adherent to the glass cover, as is the case when Abbe's experiment is performed by lamplight, appear by monochromatic sunlight, and of course in the photographs, on all parts of the frustule. Professor Abbe, who originally fell into the error of supposing the absence of the diffraction lines on the non-adherent parts to be the necessary result of the optical conditions, has pointed out with commendable frankness * that his mistake arose from not having before accurately measured the true distance of these diffraction lines apart; and has willingly admitted that under the actual conditions it is "a matter of intensity of illumination only, whether they will be visible or non-visible through a film of air." I call special attention to his lucid explanation,† because in my opinion the greater share taken by the diffraction pencils in the formation of the microscopical image in wide-angled objectives, when illuminated by monochromatic sunlight, has a great deal to do with the superiority of this mode of illumination over lamplight for the purposes of high-power definition, as well as of photomicrography. By lamplight these diffraction pencils are so much feebler in intensity, that their share in the formation of the image is considerably less. I have in a previous paper (p. 663) presented other striking illustrations of this important point, and the views there expressed are corroborated by the phenomenon observed when Abbe's experiment is performed by monochromatic sunlight.

The pair of photographs herewith presented to the Society are not from the negatives of which I sent last January to Professor Abbe the prints exhibited at the meeting of February 12th by Mr. Stephenson. Those were accidentally taken with slightly different distances, and were hence magnified differently. The present

* This Journal, vol. ii. (April, 1879), p. 141. † *Loc. cit.*

pictures are both taken at precisely the same distance from object to screen, and would be of precisely equal magnifying power, but that the diffraction lines are best seen in a focal position of the objective slightly different from that required to show the hexagons, and this produces unavoidably a trifling variation, which, however, I think cannot exceed one per cent. of the power, if indeed it is so great. I have added to the pair a third photograph, exhibiting the whole of the frustule used for this experiment, magnified 730 diameters by Powell and Lealand's water-immersion $\frac{1}{8}$.

XXXIV.—*New Species and Varieties of Diatomaceæ from the Caspian Sea.* By A. Grunow, Hon. F.R.M.S. Translated with additional Notes by F. Kitton, Hon. F.R.M.S.

(*Read* 11*th June*, 1879.)

Plate XXI.

Amphora (*angusta* Greg. var.?) *oblongella* Grunow.—A. minuta, a latere primario angusta, oblonga, polis rotundatis, valvis cymbiformis obtusiusculis, ventre plano, linea media subrecta margine inferiori approximata, striis dorsalibus subradiantibus 14–16 in ·01 mm., ventralibus brevissimis. Longit. ·032–·036 mm.; latit. ·008–·0010.

Harbour of Baku, common.

Its relationship to the very imperfectly figured *A. angusta* Greg. is very doubtful. The striæ on the ventral portion appear to be much longer—Gregory gives 17 in the ·01 mm. ("about 44 in ·001″"); still slighter is its resemblance to *A. nana* Greg., with 19 striæ in ·01 mm. The ventral striæ also appear to be shorter. The relationship of these forms is therefore scarcely probable.

A. lineata Greg. var. *subconstricta* Grun.—Frustulis in media parte levissime constrictis, striis punctatis dorsalibus 15 in ·01 mm., ventralibus tenuissimis. Longit. ·035–·045 mm.; latit. ·011.

Harbour of Baku, common.

I have frequently met with a more strongly constricted Amphora in diatom gatherings from Tahita (Tonga and Samoa Islands), which I likewise consider to be a form of *A. lineata* and have

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DESCRIPTION OF PLATE.

Fig. 1.—*Coscinodiscus nobilis* Grun., from Java, $\frac{400}{1}$.
„ 2.—*a*, *Podosira maxima* Kg., from Peru, $\frac{200}{1}$.
(*Cyclotella maxima*, authentic specimen.)
b c, Structure of inner and marginal portions of valve.
d, Two frustules of *P. maxima*, with the connecting membrane, showing the granular endochrome, $\frac{200}{1}$.
„ 3.—*P. stellulifera* Grun., Monterey deposit, $\frac{200}{1}$.
„ 4.—*a*, *Podosira ambigua* Grun., St. Paul, $\frac{200}{1}$.
b c, Structure of the inner portion and the margin of the valve, $\frac{1510}{1}$.
„ 5.—*a b*, *Hyalodiscus scoticus* (Kg.) Grun., $\frac{200}{1}$.
(*Cyclotella scotica* Kg., authentic specimen.)
(Fig. *a*, dried specimen with endochrome.)
c, Structure of valve, $\frac{1510}{1}$.
„ 6.—*a*, *P. Argus* Grun., California, $\frac{400}{1}$.
b c, Structure of inner portion and margin of valve, $\frac{1510}{1}$.
„ 7.—*a*, *P. hormoides*, Montagne, Lima, $\frac{200}{1}$.
b, Structure of valve, $\frac{1510}{1}$.
„ 8.—Small fragment of outer portion of *Coscinodiscus Gazellæ*, $\frac{400}{1}$.

called it var. *constricta*. It is somewhat larger and more robust than the Caspian form, but otherwise differs but little; striæ 12–14 in ·01 mm.

GOMPHONEMEÆ.

Gomphonema (*olivaceum* var.?) *stauroneiformis* Grun.—G. valvis lanceolatis vel subclavatis, obtusis, striis subradiantibus, subtilissime punctatis, area transversa centrali interruptis. Longit. ·053–·07 mm.; latit. valv. ·01–·012 mm.; striæ 10–13 in ·01 mm. Stipites plerumque longissimæ.

This Gomphonema is distinguished from *G. olivaceum* principally by its greater size and more conspicuous, smooth, central area. I have hitherto met with this form in mountain streams in the Tyrol and Switzerland and presume that it has often been mistaken for *G. dichotomum*.

The forms from the Caspian Sea are still larger (·065–·15 mm. long) and might be called var. *Caspia*. The upper part is frequently shorter than the lower; this is often the case with the mountain species.

MASTOGLOIACEÆ.

Mastogloia Smithii Thwaites var. *intermedia* Grun.—Minor, valvis late lanceolatis parum productis, nodulo centrali vix lateraliter dilatato, striis tenuioribus, 18–19 in ·01 mm. Longit. ·032–·037 mm.; latit. ·0125 mm.

Harbour of Baku, common.

Var. *abnormis* Grun. valvis lanceolatis, obtusiusculis, loculis ab marginis remotis, lineæ mediæ approximatis, striis subradiantibus, tenuissime punctatis, 18 in ·01 mm.

Baku Harbour, rare.

A peculiar form, in which the loculi are apparently placed between the margin and median line. I have observed something similar in a Mastogloia from Seychelles, which I have named *M. Seyshellensis*. It differs from the Caspian form by its greater length and more lanceolate valves with occasionally capitate produced apices, and its delicate striæ (26–29 in ·01 mm.).

M. (*Smithii* var.?) *pusilla* Grun.—M. minuta, valvis lanceolatis obtusiusculis, loculis mediis ceteros magnitudine superantibus, striis subradiantibus, tenuissime punctatis, 17 in ·01 mm., nodulo centrali rotundato. Longit. ·012–·013 mm.; latit. ·007–·0075 mm. Not common in the Harbour of Krasnowodsk. Resembles *M. exigua* of Lewis, but the valves are more obtuse and more strongly striate; the loculi are numerous and marginal.

[I fail to detect any resemblance between the figure of *M. exigua* and *M. pusilla;* the former has acute apices, loculi 2–5 (generally only 3), striæ obscure. In the latter the ends are obtuse, the striæ distinct, and the loculi numerous—F. K.]

NAVICULEÆ.

Navicula Trochus Ehr. var. *biconstricta* Grun.—Valves with three equal stout inflations, and slightly produced obtuse apices ·042 mm. long. Inflations ·001 mm. (this should be ·01); constrictions ·006 broad. Striæ transverse (18–20 in ·01 mm.), radiant at the centre, two large thickened sickle-shaped lines on each side of the central area.

Rare in Baku Harbour.

Although of very different form it appears nevertheless to belong to the series of which *N. Trochus* is the type, but which has only one central inflation. I have, however, many forms before me in which the ends are produced and a couple of slight depressions are visible, evidently showing a transition to the above described extreme variety. Characteristic of *N. Trochus* is the circular smooth space round the central nodule, and which has the two sickle-shaped forks on each side.

[*N. Trochus* of authors is not *N. Trochus* of Ehrenberg according to Dr. Donkin. A careful examination of the figures of *N. Follis* in the 'Mikrogeologie' will show that what has generally been considered *N. Trochus* is probably *N. Follis*. Dr. Lewis, in his paper on "Extreme and exceptional Variation of Diatoms," also refers the so-called *N. Trochus* to *N. Follis** (Professor H. L. Smith concurs in this view), but considers it to be only an extreme variety of *N. serians*, a view with which I am disposed to agree. The variety described by Herr Grunow I think more nearly resembles *N. trinode* of Lewis, *l. c.* *nec* Smith, and which he says is found in large rivers and brackish water, whilst *N. Follis* is only found in fresh.—F. K.]

N. Schneideri Grun.—N. major, valvis lanceolatis obtusiusculis, nodulo centrali oblongo, nodulis terminalibus minutis, sulcis duobus lineæ mediæ approximatis longitudinalibus, striis punctatis obliquis varie arcuatis 14 in ·01 mm. longitudinalibus 13 in ·01 mm. Longit. ·143–·145 mm.; latit. ·042 ·043 mm.

Rare on the pier of Cape Bail.

A well marked *Navicula;* on each side of the median line is a conspicuous line of coarse striæ, between which and the striæ is a narrow, smooth furrow, connecting it with the subsection Diploneis, but distinguished from it by the striæ which cross the valve in curved oblique lines resembling those on *N. oblique-striata* A. Schmidt, Demerara River. Atlas, pl. 13, figs. 41, 42.

[*N. Iridis* has a similar striation.—F. K.]

* The figure, in the 'Infusionsthierchen,' of *N. Trochus* is certainly very like what is usually known by that name; the probable solution is that they are both one species.

Pleurosigma.

Pleurosigma attenuatum, var. *Caspia* Grunow.—Somewhat smaller, narrower, and less sigmoid than the type species, apices less acute. Striæ the same as in *P. attenuatum* and *P. Hippocampus.*

Not uncommon in Baku Harbour.

Between *P. attenuatum* and *P. Hippocampus* there exists only the unimportant distinction, a difference in the outline of the valve. The Caspian form is distinguished from both by being narrow, less sigmoid, and by its more obtuse apices. The structure of these allied forms under high powers appears very similar; between the strongly-marked lines of beads faint outlines of other beads may be seen. Whether these delicate puncta belong to a second valve or are an optical delusion must remain for the present undecided; it is certain, however, that the valves of Pleurosigma are composed of two layers, which separate when acted upon by long boiling in acids. [I have observed this in *P. angulatum.*]

[The faint markings here alluded to have been seen by other observers. It is most probable that the valves of Pleurosigma have a similar structure to many other diatoms in possessing what I call "secondary valves," which in some genera are like, and in others unlike, the primary valve. Schmidt calls them Regenerationshulle. —F. K.]

P. elongatum, var. *gracile* Grunow.—Narrower and less sharply pointed than Smith's figure. Striæ somewhat stronger. Oblique striæ, 17–18 in ·01 mm.; transverse, 19 in ·01 mm. Length, ·13–·32 mm.; breadth, ·024–·025 mm.

Common in Baku Harbour.

Schizonema.

Schizonema (*minutum* Kg. var.?) *Caspium* Grunow.—Sch. minutissimum, filamentis brevissimis, subsimplicibus vel parce dichotome ramosis, inferne irregulariter transverse rugosis, superne lævibus, hyalinis, apicem versus vix conspicuis. Frustula inclusa irregulariter libera disposita, valvis lanceolatis, obtusiusculis, ·035–·052 mm. longis, ·007–·008 mm. latis, nodulo centrali parvo oblongo, striis parallelibus 12 in ·01 mm., in media parte parum distantioribus, subradiantibus, in area minuta nodulum centralem ambiente deficientibus.

On *Cladophora* in Baku Harbour common.

In *S. minutum*, Kg. Bac., pl. 23, fig. 5, the frustules occur in straight lines, in which it resembles *S. humile* Kg.; but in the latter species they principally occur in the chief filament (Hauptschlauch). In the Caspian form this is never the case.

NITZSCHIEÆ.

[We omit the remarks of the author on this family, as we hope his monograph will be in the hands of the diatomist ere long. He unites the genus Tryblionella with Nitzschia, remarking that "long observation of this genus (Nitzschia) had convinced him that the genus Tryblionella was not sufficiently distinct to warrant their separation;" he therefore relegates the following forms to the former genus.—F. K.]

T. Hantzschiana Grun., *T. gracilis* W. Sm. = *N. Tryblionella* Hantzsch. *T. Victoriæ* Grun. and *T. levidensis* W. Sm., he considers to be only varieties of that species. Baku Harbour.

T. punctata W. Sm. Baku Harbour.

T. apiculata Greg. [not W. Sm. as stated by Grunow].

T. circumsuta Bailey = *Surirella circumsuta* Bailey = *T. Scutellum* W. Sm. Common in Baku Harbour.

The valves of this species have a longitudinal ridge (längsfaltig), but the transverse striæ are not interrupted by it as they are in many other species. By direct light the surface of the valve appears irregularly punctate (shagreen-like); this is still more conspicuous in the closely allied form *Nitzschia Brightwellii* (Kitton), in which it is clearly shown that the large puncta and the fine regular lines of striæ belong to different layers of the valve.

[The striæ on *T. circumsuta* and *N. Brightwellii* have a certain family resemblance, but the structure of the valve is conspicuously different in the former species. Close to the punctate margin runs a longitudinal V-shaped furrow, forming a ridge near the centre of the valve, which gradually descends towards the margin; a section made across the centre of the valve would be something like three-fourths of the letter W, \\. This peculiarity is more or less visible in all the Tryblionellæ. *Nitzschia Brightwellii* has the surface of the valve flat, like all the true Nitzschias. *T. circumsuta* is elliptic lanceolate. *N. Brightwellii* is linear lanceolate.—F. K.]

Nitzschia Sigma W. Sm. var. *intercedens* Grun. Length, ·2 mm.; breadth, ·0065 mm. Keel puncta, 7 in ·01 mm.

N. Sigma embraces a great number of forms, the extremes of which would not with certainty be relegated to one species were it not that so many intermediate forms exist between them. The following are the principal:—

Var.? *maxima* Grun. Length, ·9 mm.; breadth, ·9 mm.; keel puncta, 3–4 in ·01 mm.; transverse striæ, 15–18 in ·01 mm.

Var. *valida* Grun. Length, ·5 mm.; breadth, ·017–·022; keel puncta, 3½–5 in ·01 mm.; transverse striæ, 18–21 in ·01 mm.

Var. *consimilis* Grun. Length, ·4 mm.; breadth, ·013 mm.; keel puncta, 5–7; transverse striæ, 23–26 in ·01 mm.

This form stands midway in the transition from *N. Sigma* proper.

Var. *genuina* Grun. Length, ·25 mm.; breadth, ·011 mm.; keel puncta, 7–9; transverse striæ, 20–24 in ·01 mm.

Var. ? *fasciculata* Grun. Length, ·095 mm.; breadth, ·036 mm.; keel puncta, 4–6; transverse striæ, 28–30 in ·01 mm. It is the *Homeocladia sigmoidea* W. Sm., at least what I have hitherto considered to be that species. I cannot admit that it is a Homeocladia. It is distinguished from *N. Sigma* proper by its distant keel puncta as well as by its delicate striation.

Var. *intercedens* Grun. Length, ·30 mm.; breadth, ·009 mm.; keel puncta, 6–7; transverse striæ, 28–33 in ·01 mm.

Var. ? *Sigmatella* Gregory. Length, 32 mm.; breadth, ·006 mm.; keel puncta, 8–10; transverse striæ, 25–28 in ·01 mm. Valves more or less strongly sigmoid.

[*Nitzschia Sigmatella* Gregory is no Nitzschia. Wm. Smith also refers this form to the genus Nitzschia under the sp. name of *curvula*. Dr. Lewis considersit an extreme form of Surirella, and names it *S. intermedia*. I have seen authentic specimens of *N. Sigmatella* and *N. curvula* W. Sm., and am satisfied that they are identical, and also that they are not allied to Nitzschia excepting in outline.—F. K.]

Var.? rigida Grun. Length, ·20 mm.; breadth, ·008; keel puncta, 8–11; transverse striæ, 28–32 in ·01 mm. According to Dr. Arnott this is *Amphipleura sigmoidea* W. Sm. (*A. rigida* Kg.?). A small form of this is perhaps *Navicula lamprocampa* Ehr. in Kg. B. *Nitzschia flexa* Schumann appears to belong here.

Var. *anguilla* Schumann. Valves acute; 0·045 mm. in length; ·003 mm. in breadth; keel puncta, 11–12; transverse striæ, 29–30 in ·01 mm.

Var. ? *Clausii* Hantzsch. Resembles the preceding. Valves with produced rounded apices, ·015 mm. long, ·004 mm. broad; keel puncta, 10–11 in ·01 mm.; striæ very delicate.

In this series (in which the distinctions are based upon the size of valve, and distance of keel puncta and striæ) may be included some irregular forms.

Var. ? *subrecta* Grun. Valve lanceolate sigmoid, flexure very slight, often scarcely distinguishable. Length, ·11 mm.; breadth, ·008 mm.; keel puncta, 10–11; transverse striæ, 28–30 in ·01 mm.

Var.? *abludens* Grun. Valve linear lanceolate, not sigmoid. Length, ·155 mm.; breadth, ·008 mm.; keel puncta, 3–4½; transverse striæ, 22 in ·01 mm.

To the *Nitzschia Sigma* group belong the following species of Homœocladia.

H. Kotschyi Grun. Valve, ·22 mm. long, ·007 mm. broad; keel puncta, 7–7½; transverse striæ, 24 in ·01 mm.; connecting zone with strong longitudinal striæ. Salt Lake Atchin Ghöl (*leg.* Kotschy), growing singly and in tufts.

H. subcohærens Grun. Valve, ·03–·045 mm. long, ·004 broad; keel puncta, 9–10; transverse striæ, 33–34 in ·01 mm., forming slight, delicate, and frequently ramifying threads, without a definite integument. China, Bengal.

Herr Frauenfeld gathered a similar form in Leith, Scotland; it was partly in single frustules and partly in bushy tufts.

Licmophoreæ.

Licmophora flabellata Ag. Kg. Bac. tab. 12, figs. 1, 2, 4; W. Smith, B. D. tab. xxxii. fig. 234.

Var.? *gracillima* Grun. Frustules shorter and narrower (·101 mm. long, ·009 mm. broad); in the upper part linear, the lower cuneate. Rare.

I have never seen this form in a living state, but only in single frustules. I have also seen no front view, and am therefore unable to decide whether it is allied to *L. Remus* or *L. Romulus.*

Coscinodisceæ.

Cyclotella Caspia Grun.—C. minuta, margine tenuissime striato, centro undulato, irregulariter punctato. Diam. ·18 mm.; latit. marginis, ·004 mm.; striæ radiantes, 21 in ·01.

Not uncommon in the Harbour of Baku.

Approaches most nearly to *C. operculata* Kg., but is distinguished by the absence of marginal puncta (spines?) and by its delicate striæ. I reckon as Cyclotellæ only those forms with sharply-defined radiating marginal striæ. To distinguish the species requires great caution. *C. operculata* has a strongly striated margin (striæ 16–17 in ·01 mm.).

C. antiqua W. Sm. is closely allied to *C. operculata.* It is distinguished by the presence of large triangular excavations near the centre. I have observed many transitional forms in *C. operculata* var. *radiosa.*

To the large forms of *C. operculata* is allied a Cyclotella, which Eulenstein found in the Bodensee (Lake Constance) and named it *C. Bodanica,* and which I also have seen in soundings from the Traunsee (Lake of Gmunden).

The largest were ·06 mm. in diameter, with broad (·015 mm.)

margins; the puncta (spines) submarginal; the radiating striæ on the inner part of the margin 11 in ·01 mm., on the outer part about 13 in ·01 mm. The centre is marked with (excepting a small speck in the middle) delicate radiating puncta.

To *C. Bodanica* Eulenstein joins a not uncommon North American Cyclotella, which is distinguished by its smaller size and more distant punctate lines in the centre, and which I at one time called var. *affinis.*

C. Dallasiana W. Sm., a common form in brackish water localities; it is distinguished from *C. operculata* by its much greater size, stronger striation of the marginal band (9–12 in ·01 mm.), and a semicircular arch of larger puncta on the edge of the irregularly punctate centre. [The puncta are distinct on the specimens from Para River, but their presence is doubtful on those from many other localities.—F. K.] To *C. Dallasiana* may possibly belong *Coscinodiscus striatus* Kg. and *Discoplea sinensis* Ehr. Dr. Arnott, in his note on the genus Cyclotella, 'Q. M. Journal,' vol. viii. p. 247, refers *C. stylorum* * Brightwell, 'Q. M. J.,' vol. viii. p. 96, to *C. Dallasiana.* Brightwell's form I know well, and have seen the original specimen from which the figure (a very indifferent one) was made. The *C. Dallasiana* of Smith, of which I have also seen authentic specimens, differs considerably from *C. stylorum.* The marginal band is narrow and finely striate; the large granulate centre is undulate, but not the whole valve. *C. stylorum* also shows this, but in a much less degree. In the latter the marginal band is much broader, the striæ stronger, and the valves much more robust; it is moreover a much commoner form. I have it from many North American localities, the Para River mud, South America, and in mud from the mouth of the Rokelle, Sierra Leone (where Mr. Brightwell first observed it). I do not know of any British habitat. *C. Dallasiana,* on the contrary, is much less common. Smith found a single specimen in a slide of a gathering from the Medway. Mr. Roper detected it in Thames mud. It also occurs in the Para River mud. I know of no other habitats. Those from the Para are very fine, and the depression and elevation of the centre very distinct. I am disposed to refer the form called by L. W. Bailey † *Cymatopleura (?) Campylodiscus,* to this species. His description is as follows:—" Large, lateral view almost circular, sometimes broadly oval (his figure is perfectly circular; the oval appearance might be caused by the valve being tilted); marginal striæ short, close, and showing under a high power gland-like dots. Lateral valve with one deep undulation, surface finely striated. Hab. Honeylake Valley, foot of Sierra Nevada."

* In the work referred to, Dr. Arnott says *C. radiata:* this is an error; in the copies of his paper (privately distributed) he alters it to *stylorum.*

† 'Boston Journ. of Nat. Hist.,' vol. vii. p. 350, pl. 8, fig. F.

He does *not* notice its presence in the Para mud, where it is not very rare: this perhaps throws suspicion on the identity of the two species. He, however, notices another form, which he thinks is a var. of his *C. pulchella* (which he says is perhaps the same as *stylorum*), "and well deserves the name" (*l. c.* p. 348).

In the work just above quoted is a figure of what he calls *C. Kützingiana* var. and which he describes thus: "The central portion is large, elevated, and irregularly punctate; the striæ are minute and closely radiant, reaching the margin, but interrupted before reaching the margin by a finely undulate circle." His figure very much resembles that of *C. Caspia;* the centre is, however, larger and more finely punctate; it is also very like the small valves of *C. stylorum.*

C. compta Ehr. has a resemblance to *C. Meneghiniana* Kg., but differs in its more strongly granulate centre, and that every second, third, or fourth marginal stria is stouter than the others.

C. Meneghiniana Kg. is identical with *C. rectangulata* Breb., and like *C. Caspia,* has no marginal spine, but a more strongly striated margin (7 to 9 delicately punctate striæ in ·01 mm.). *C. Kützingiana* W. Sm. appears to be the same species.

C. Kützingiana (Ehr.?) Chauvin, has, according to original examples from Chauvin, likewise no marginal spines, but a very delicately striate margin (12–14 in ·01 mm.). *C. Caspia* perhaps might be considered a very delicately striate form of this species. In kieselguhr from Domblitten is found a very interesting form with an oval centre and 14–15 marginal striæ in ·01 mm. This I consider a var.? of *C. Schumanni.*

The remaining species of Cyclotella is *Discoplea græca* (Ehr.?) Schumann; *D. umbilicata* (Ehr.?) Schumann, and *D. bipunctata* Schumann seem to be of similar structure. Most of Ehrenberg's species are unrecognizable.

C. scotica Kütz. appears, according to the original examples from Constantinople (query, identical with the Scottish form?), to be no Cyclotella, but a Podosira; the entire valve is very delicately and irregularly punctate, and beset with a single circlet of stout spines.

Discoplea annulata Schumann seems to be allied to *Melosira Westii,* and *D. umbilicata* Ehr. to be identical with the latter.

Cyclotella bella A. Schmidt.—This is perhaps a Stephanodiscus, or may belong to the genus Coscinodiscus. The same applies to *C. punctata* W. Sm., *C. Astræa* and *minutula* Kg. (these two appear to merge completely into each other). *C. Carconensis* Eulenstein does not belong to *C. Astræa* as Eulenstein considered, but is a good species, characterized by the smooth radiating lines starting from the intramarginal spines, and which pass through the radiant puncta. *C. spinosa* Schumann is identical

with *Stephanodiscus Niagaræ* Ehr. The latter is distinguished from *C. Carconensis* by the greater number of smooth rays separating the radiating puncta, part only of which proceed from the marginal spines. The lines of puncta in *S. Niagaræ* are simple in the centre, but consist of two, or at most three, contiguous puncta as they approach the periphery, whereas the lines of puncta in *C. Carconensis* occur in groups.

Dr. Arnott, in the paper previously quoted (p. 246), says: "Smith unfortunately referred a species (*C. minutula*) obtained in Lough Mourne deposit to *C. antiqua*, a species which does not occur in any of the Irish deposits which I have examined." It is somewhat difficult to imagine how Professor Smith could have mistaken *C. minutula* for *C. antiqua*, the difference being so well marked. I have never been able to find the latter in the Lough Mourne deposit or in the marl Co. Down, but in a deposit from Strangford, Co. Down, it is not uncommon, and I think finer than in the Peterhead deposit.

Melosireæ.

Melosira Borreri Greville. Sm. S. B. D. tab. 50, fig. 330.

Var. *moniliformis* = *M. moniliformis* Ag. Kützing, Bacil. tab. 3, fig. 2.

Var. *subglobosa* Grun.—Generally somewhat smaller. Frustules nearly spherical or elongated, the ends slightly flattened.

Var. *octogona* Grun.—Frustules nearly cylindrical, with flat ends and broadly oblique corners, so that the frustules in f. v. appear octagonal.

The three varieties are not uncommon in Baku Harbour.

The filaments are attached by a short stipes to other algæ, particularly Cladophora. The frustules are sometimes attached to each other and sometimes connected by a short gelatinous isthmus.

The interesting var. *octogona*, which I for a long time thought a very different species, and which I first found on *Vaucheria javanica* Kg. from Java, had such oblique corners to the cylindrical frustules that I could not recognize its relationship to *M. Borreri*. I afterwards found examples which more nearly approached *M. Borreri* on algæ from Upolo, Australia, and Kamtschatka, and which stood between it and the typical *M. Borreri*, from the Lagunes of Venice. The vars. *octogona* and *suborbicularis* are usually more finely punctate than *M. Borreri*; the latter has frequently the central part of the valve smooth, whilst the former almost always have it punctate. The puncta in all the forms of

M. Borreri are in groups and irregularly disposed, so that the valves have a shagreen-like appearance.

Podosira lævis Greg. does not appear to me to differ from *P. Montagnei*.

P. hormoides (Montagne *nec* W. Smith) = *P. nummuloides* Ehr.—According to the original examples, approaches very near to *P Montagnei*, and differs principally in the valves being less convex. The structure is very similar, but the puncta are more distant (18 in ·01 mm. against 21–22 in *P. Montagnei*), and the larger puncta are fewer in number and more radiant.

[The arrangement adopted by Herr Grunow is that of Pfitzer, who divides the Diatomaceæ into two groups, Placochromaticæ and Coccochromaticæ. See O. Meara's Analysis of Dr. Pfitzer's System in 'Q. M. J.,' vol. xii., n. s., and M. P. Petit's in 'M. M. J.,' vol. xviii.—F. K.]

[Since the preceding paper was written I have received from my friend Herr Grunow the following notes on Coscinodiscus, Hyalodiscus, and Podosira.—F. K.]

Coscinodiscus nobilis Grun.—This is the form I refer to *C. regius* Wallich in my paper on Diatoms from the Caspian Sea (p. 27*: "Zu dieser durch ein glattes Centrum ausgezeichneten Gruppe gehören noch *C. perforatus* Ehr. und *C. apiculatus* Ehr., so wie *C. regius* Wallich"). It is not *C. regius*, of which, through the kindness of Mr. Kitton, I have since seen specimens. It is much larger (1·4 mm.) than *C. nobilis* whose greatest diameter is ·54 mm. *C. regius* has no smooth centre, but a wide space in the middle covered with irregularly disposed puncta, and distant, variously shaped, slightly curved spines. The valves are cylindrical and in s. v. have radiant lines of puncta (3 in ·01 mm.). On the cylindrical part (f. v.) the puncta are parallel (5 in ·01 mm.) and are separated from the radiant rows by a circular smooth space on the upper edge of the valve. The slightly convex valves of *C. nobilis* have a smooth centre and closer and smaller puncta (about 7 in ·01 mm.) which become hexagonal as they approach the margin, and are separated into groups by radiating lines which are sometimes scarcely visible. I have a smaller form from the Samoa Islands (·06–·13 mm.) with a smooth centre and more radiating puncta (5 in ·01 mm.). It resembles *C. apiculatus* Ehr., and might be named *C. apiculatus* var. *Samoensis*. A similar form occurs in the Monterey deposit. *C. nobilis* was collected by Krock, and communicated to me by Professor Cleve. Pl. XXI., Fig. 1, $\frac{450}{1}$.

* Not noticed in my *résumé*.—F. K.

C. Gazellæ Janisch.—Diameter of valve (as far as can be ascertained from fragments), 1·8 to 1·9 mm., thus exceeding even *C. regius* in size. Centre smooth, like *C. nobilis*, but bordered by a circle of small spines similar to those occurring in *C. regius*; the radiating rows of puncta are somewhat closer than those in that species (6–7 in ·01 mm.). Upper edge of valve smooth, precisely as in *C. regius*. Near the margin numerous short irregularly curved striæ (consisting of darker puncta) are visible.

'Gazelle' sounding, No. 125, 30° 53′ S. lat., 177° 6′ E. long.; depth 4151 metres. 'Challenger' sounding, station 265, depth 2900 fathoms. This form was named by Herr Janisch in remembrance of the scientific expedition made by the German ship, 'Gazelle,' in the years 1874–1876. Pl. XXI., Fig. 8 ($\frac{450}{1}$).

I have found fragments that can only belong to this species in a sample of Nottingham deposit in which it was not uncommon.

C. regius was originally distributed under the MS. name of *Rex*. It is undoubtedly the largest diatom, excepting *C. Gazellæ*, hitherto discovered. *C. regius* was first found, in the Bay of Bengal in 1857, by Dr. Wallich. The lighter portions of one of the 'Challenger' dredgings (station 265, depth 2900 fathoms) consist almost entirely of fragments of this species. *C. nobilis* is by no means an uncommon form; I have found it in the stomachs of Noctilucæ collected at Gorleston Pier (Norfolk), associated with *C. concinnus*, for which it is sometimes mistaken. I have also seen it in gatherings from Harwich, Hong Kong, Arafura Sea, and Sea of Java. It differs from *C. concinnus* in its large smooth area and its more distinct puncta and radiating lines. The rows of puncta in *C concinnus* terminate in a small central rosette of small cells. *C. tenuis* Bailey * is undoubtedly the same species, † as is *C. centralis* of Schulze.

In 'Casp. See Algen,' Herr Grunow says, "Allied to *Podosira hormoides* is a form which I provisionally call *Hyalodiscus maximus*. It is without doubt identical with *Cyclotella maxima*." In the communication now received are the following additional remarks.

Podosira maxima (Kützing) Grunow, in Cleve and Grunow's 'Arctic Diatoms.' *Cyclotella maxima* Kütz. ad specm. authent., *Hyalodiscus maximus* Grun. *l. c.* ex parte, *Actinoptychus interpunctatus* Brightwell. — I have adopted with some hesitation

* 'Boston Journ. of Nat. History,' vol. vii. p. 393, pl. vii. fig. 9.

† Bailey (*l. c.*) also says, "that he has seen from the same locality (Para River) a similar form with three processes." (I have seen *C. radiatus* with similar processes.) This is no doubt the same species as that found in the Java Sea. The so-called processes are not constant, and are probably only abnormal growths; see Prof. H. L. Smith, 'Amer. Jour. of Micr.,' Aug. 1877.—F. K.

M. Petit's views in separating *Podosira* from *Hyalodiscus* on account of the granular arrangement of the endochrome, and therefore remove this species from *Hyalodiscus*. The puncta are in radiant and oblique lines 13–15 in ·01 mm. in the middle and 18 on the margin of the valve. The beginning of new rays of puncta is mostly marked by a small blank space which appears under certain focussing like a small dark spot. The centre of the valve is more irregularly punctate, and occasionally a very small irregularly bordered umbilicus is visible. Californian specimens reach a diameter of ·24 mm. and have somewhat coarser puncta (12–14 in ·01 mm.), but it is impossible to separate them into distinct species, and they can only be considered as a variety "*Californica*" of *P. maxima*. Pl. XXI., Fig. 2 *a* ($\frac{900}{1}$), authentic specimen of *Cyclotella maxima* Kg. from Peru (*leg.* Hayne). Fig. 2 *b*, structure of the inner part of the valve ($\frac{1510}{1}$). Fig. 2 *c*, structure of the margin ($\frac{1510}{1}$). Fig. *d*, two frustules cohering by a broad connecting membrane, of rare occurrence, but which evidently shows how nearly allied *P. maxima* is to *P. hormoides*. The two frustules exhibit the granular arrangement of the endochrome ($\frac{200}{1}$).

P. hormoides Montagne (*nec* Smith) is nearly allied to *P. maxima*, and differs only by its smaller size, more convex valves, and somewhat closer puncta. The cell contents are granular. As with other diatoms, we find in some gatherings of *P. hormoides* and *P. maxima* certain specimens not varying much in size, which lead to the conclusion that we have to do with distinct species; but in gatherings from other localities intermediate forms appear, and I have scarcely any doubt that *P. maxima* is only a large form of *P. hormoides*. Pl. XXI., Fig. 7 *a* ($\frac{900}{1}$), authentic specimen from Lima. Fig. 7 *b* ($\frac{1510}{1}$), structure of the valve.

P. ambigua Grun. in Cleve and Möller, 'Arctic Diatoms.' (*Hyalodiscus stelliger* Grun. *nec* Bailey Novara ex parte.)—This species is distinguished from *P. maxima* by a much larger and more sharply defined dark umbilicus, its smaller size and somewhat closer rows of puncta (15–17 in ·01 mm. in the middle of the valve). Common at the island of St. Paul, Cape of Good Hope, Kerguelen's Land, &c., and is very constant in these localities, where *P. maxima* does not occur. I have seen specimens of *P. maxima* from other localities with a small umbilicus, and other intermediate forms may probably be detected. The cell contents are granular. *Hyalodiscus subtilis* is distinguished by its much finer striation and coherent endochrome, which sometimes form radiant lobes easily visible even in dried specimens. A very large form of *P. ambigua* (var. *Kamschatica*), attaining a diameter of

·274 mm. (umbilicus ·035 mm.), occurs rarely in the Sea of Kamtschatka. From St. Paul, Southern Ocean, Pl. XXI., Fig. 4 *a* ($\frac{900}{1}$). Fig. 4 *b*, *c* ($\frac{1510}{1}$), structure of inner part and margin of valve.

P. stellulifera Grun., 'Casp. See Algen,' p. 35.—This form is distinguished from *P. hormoides* and *P. maxima* by a circle of larger puncta (spines ?) near the margin of the highly convex valve which has a broad border. The stellate appearance of the blank dots is not always so obvious as in the specimen here represented, and I have seen a specimen where the inner part very much resembled *P. hormoides*. Pl. XXI., Fig. 3 ($\frac{900}{1}$), Monterey deposit.

[In the 'Casp. See Algen,' p. 35, is the following additional description. Diameter of valve, ·08 mm. With the exception of the irregularly punctate centre (about ·01 mm. in diameter), the valve has delicate radiating puncta (17–18 in ·01 mm.). The larger puncta are irregularly scattered, and have a peculiar stellate appearance. The cell membrane is somewhat thick. The large marginal puncta (spines ?), 4 in ·01 mm. This form, which occurs in Herr Weissflog's collection, I name *P. stellulifera*.]

P. Argus Grun., 'Casp. See Algen,' p. 35.—Valve highly convex; diameter, ·107 mm.; cell membrane very thick. The inner concave valve is delicately striate; striæ radiant (16 in ·01 mm). On the convex side is a sharply defined circular space, with a finely dentate margin, within which are three to four concentric circles of large oval dots (depressions ?). California, in the collection of Herr Weissflog. Pl. XXI., Fig. 6 *a* ($\frac{450}{1}$); 6 *b*, *c*, structure of inner portions and of the broad border of the valve.

Hyalodiscus scoticus (Kg.) Grun., in Cleve and Grunow's 'Arctic Diatoms.' (*Cyclotella scotica* Kg. ad specm. authent. *Podosira hormoides* Wm. Sm. *nec* Mont. *P. Franklini* Grun., 'Casp. See Algen,' p. 34.) I have, through the kindness of Dr. Van Heurk, seen authentic specimens of *C. scotica* Kg. from two Scotch localities. I am unable to say whether the *C. scotica* from Constantinople, to which I alluded in the 'Casp. See Algen,' p. 30, is identical, my preparation being mounted dry and insufficiently cleansed, but the Scotch specimens are without doubt the *P. hormoides* of W. Smith. I have never seen the granules in the endochrome of this very common species, and there can scarcely be any doubt of its belonging to the genus *Hyalodiscus*. A stronger reason for uniting it to this genus is the absolute impossibility of specifically distinguishing it from *H. subtilis*. Anyone who doubts this has only to carefully examine the Californian gatherings, or No. 2 of Cleve and Möller's from Finnmark, in which every possible intermediate form may be seen, to

be convinced of the correctness of this view. Pl. XXI., Fig. 5 *a*, *b* ($\frac{900}{1}$), *Cyclotella scotica* Kg. from Scotland; 5 *c* ($\frac{1570}{1}$), structure of valve.

In a future paper I hope to give delineations of some forms of *H. lævis* Ehr., *H. radiatus* (*Pyxidicula radiata* O'Meara), and *H. maximus* Petit.

RECORD

OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.,

including Embryology and Histology generally.

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Cell-division in Animals.*—An important research on this subject is published by Professor Peremeschko, of Kiew, who has studied the epidermis, connective-tissue corpuscles, white blood-corpuscles, and spindle-shaped cells from which the blood capillaries are developed, in the transparent larva of the newt (*Triton cristatus*).

Method.—For the examination of the living cells it was found convenient, although not absolutely necessary, to curarize the larva. One part of curare was dissolved in 100 of water, and 100 of glycerine added: five to ten drops of this fluid were added to a watch-glass of water, in which the larva was placed. When the movements had become slow and feeble, the animal was removed to a slide, a cover slip placed on the tail, the most convenient part for study, and the rest of the body covered with moist blotting-paper. The larva recovers from the effects of the drug after eight to ten hours, and can therefore be used over and over again.

Immersion in 3 per cent. alcohol or ether was found useful if the observation was not to be continued long. Sodium chloride solution (1 per cent.), iodized serum, solution of sugar, &c., were also found of service, as rendering certain appearances more distinct.

Absolute alcohol was found to be the best hardening fluid: small pieces of the tail were placed in it for a quarter of an hour, stained with hæmatoxylin, fuchsin, or neutral carmine solution, and mounted in glycerine or dammar. Solutions of gold chloride and osmic acid ($\frac{1}{2}$ to $\frac{1}{4}$ per cent.), and silver nitrate ($\frac{1}{2}$ per cent.) were also employed.

Results.—After treatment with curare or sodium chloride solution, the epithelial cells of the epiderm were observed to become much better defined, and spaces to appear between them, crossed by delicate filaments; these were evidently pseudopodial processes, arising as a result of the contraction of the cells induced by the action of the reagent.

Changes in the form, size, and arrangement of the intranuclear filaments were directly observed; the changes, however, were so slow that no actual movement could be seen. The changes of the dividing nucleus described by other observers were seen, and it was further

* 'Arch. Mikr. Anat.,' xvi. (1879) p. 437.

noticed that, as the cell itself became constricted preparatory to division, pseudopodial filaments stretched across the small space between it and its neighbours, these processes being sometimes so numerous as to form a sort of fringe.

The ordinary epidermic cells showed no intracellular network, but amongst them were found a greater or less number of cells in which this network was remarkably well developed. These "reticulate cells" (Netzzellen) are often twice as large as the others, and of a more rounded form; they have compact, oval nuclei, which, as usual, may become broken up into filaments, all stages between the two conditions being observed. Nuclear filaments were seen to extend between those of the intracellular network, but no actual connection of the two seems to have been observed.

The reticulate cells are formed from those of the usual character by a network appearing around the nucleus, and gradually extending to the periphery. They may return to the ordinary condition by a reversal of the process: the filaments of the network undergoing gradual fusion, from the periphery inwards.

The entire process of division took two hours and a half in the ordinary, one hour and a half in the reticulate cells. In both cases three-quarters of this time was occupied in the division of the nucleus, one-quarter in that of the cell-body. The process is thus a slow one, not as in plant cells, according to Strasburger, rapid.

The series of events which together constitute the division process are as follows:—The nucleus, first of all, undergoes a considerable increase in size; next, there appear in it a few lumps or granules, some larger, some smaller; the number of these increases; they lengthen out, and form short, finer or coarser filaments, which are at first scattered without any definite arrangement, and intermixed with unaltered granules through the nucleus. The number of the granules decreases, the filaments become longer, the contours of the nucleus vanish, and the filaments group themselves, sometimes about a centre, in more or less regular forms, producing the filamentous differentiated nucleus of authors.

Development of the Ribs and the Transverse Processes.*—Herr Fick is of opinion that the ribs have an independent and separate origin to the superior arches of the vertebræ; and that, likewise, the transverse processes are not budded off from the superior arches, but are differentiated from the tissue that lies to the sides of the cartilage of these parts. Taking as an example the third myocomma, he shows that towards its peripheral end there is a rounded tongue of cartilage, which, decreasing in size, extends towards the chorda; at its most central end there are distinct cartilage-cells, and the whole structure is separated from the surrounding muscular tissue by a layer of spindle-shaped nuclei, which seems to form the embryonic perichondrium; from this the "superior arch" is in section seen to be distinctly separated.

* 'Arch. Anat. und Entw.' (His and Braune), (1879) p. 30.

Connective Tissue.*—Dr. L. Löwe gives the following *résumé* of the various kinds of connective tissue found in the human subject:—

A. *Interparenchymatous Connective Tissue.*

a. Lamellar interparenchymatous connective tissue.
b. Elastic " " "
c. Lamellar elastic " " "

B. *Parenchymatous Connective Tissue.*

a. Mucous parenchymatous connective tissue.
b. Fibrillar " " "
 α. Tendon.
 β. Tissue of the fasciæ.
 γ. " fontanelles and osseous sutures.
 δ. " dura mater.
 ε. " perichondrium.
 ζ. Tissue of the periosteum.
 η. Erectile tissue.†
 θ. Tissue of cicatrices.
c. Elastic parenchymatous tissue.
d. Adenoid " "
 α. Diffuse.‡
 β. Proper tissue of the lymph glands.
 γ. Tissue of the spleen.
 δ. Tissue of granulating wounds.
 ε. Fœtal osseous medulla.
 ζ. Fœtal fatty tissue.
e. Fatty tissue.
 α. The subjacent tissue of the so-called fat-organs.
 β. The fatty tissue of the osseous medulla.
f. Chondroid parenchymatous tissue.
g. Cartilage.
h. Bones.
i. Dentine.

C. *Intraparenchymatous Connective Tissue.*

a. Mucous intraparenchymatous connective tissue.
b. Fibrous " " "
c. Elastic " " "
d. Neuroglia.§

Sexual Organs of Teleostei. ‖—In a monograph on the anatomy and histology of the reproductive organs of bony fishes, Dr. J. Brock describes both the coarse and the minute structure of these organs in a large number of types. We abstract the following from the histological portion of the paper.

Male Organs.—The minute structure of the testis, like its external

* 'Arch. Anat. und Entw.' (His and Braune), (1879) p. 43.
† This is well seen in the walls of the lachrymal duct of the rabbit.
‡ This in the mucous membrane of the digestive tract of mammals.
§ This appears to be a special form of connective tissue.
‖ 'Morphol. Jahrb.,' iv. (1878) p. 505.

form, undergoes great changes during the breeding season. These changes affect not only the quality and quantity of the secretion, but even the form of the ultimate constituents of the gland.

However the structure of the mature testis may differ in different fishes, that of the unripe gland is the same in all. It is made up of polygonal acini, containing a rounded or slit-like lumen, so that the whole gland viewed as a transparency under the Microscope, presents a number of regular polygonal areas.

In respect of the structure of the ripe testis, the Acanthopteri are very sharply distinguished from other Teleostei. The glandular substance is arranged in long, blind tubules arranged in a radiating manner around a centre formed by the hilus or place of exit of the vas deferens. In the remaining members of the group, the testis is formed on what Brock calls the Cyprinoid type. The tubuli form numerous anastomoses with one another, and so produce communicating spaces, the gland, in typical specimens (Cyprinoids), having a spongy appearance. This difference in the structure of the adult gland, notwithstanding the similarity of the young condition in the two types, is due to the fact that the increase in size of the organ, during the breeding season, comes about as a result of an independent increase of the elements of the gland in obedience to a fixed law, and is not primarily due to a mechanical dilatation by the accumulated sperm.

The author believes that the tubules are not separated from one another by interstitial tissue, and that they possess no true tunica propria, but that they rather represent a series of lacunæ (Hohlräumen), the partitions between which spring, on the one hand, from the tunica propria of the testis, while, on the other hand, they are immediately continued into the partitions of the vas deferens.

The epithelial cells of the gland are large and round, with finely granular contents, a large, clear nucleus, and no demonstrable membrane. The first step in the formation of the spermatozoa is the multiplication of the nuclei, the process not taking place simultaneously in the whole acinus, but beginning with a few cells, or it may be with but a single cell. By a repetition of this process the original epithelium disappears, and in its place are found large cells, filled with granules (Inhaltskörperchen), which stain deeply with carmine or logwood, and are probably the descendents of the original nuclei. From these granules the spermatozoa are formed. After the ripening of the latter it seems probable that the spermatic cells form multinucleate masses of protoplasm, without distinct cell-boundaries, that these divide into as many daughter-cells as there are nuclei, and so reproduce the original epithelium.

Female Organs.—The ovary presents great differences in the arrangement of the ovigerous surfaces; these will be best seen from the following table.

A. Ductless ovary.
  1. Ovary consisting of a simple lamina (*Anguillula*).
  2. Ovary consisting of numerous laminæ (*Salmonidæ*)

B. Ovary with duct.
1. Ovigerous surface confined to a narrow strip of the wall of the ovary, or forming a duplicature of the wall, with which it is in connection by narrow stripes (*Scorpæna*, &c.).
2. The greater part of the ovarian wall bears ova.
   a. Ova originate in irregular processes of the wall (*Lophobranchii*, &c.).
   b. Ova originate in definite lamellæ or duplicatures of the ovarian wall.
      1. Lamellæ parallel to long axis of ovary.
         α. Whole wall of ovary beset with lamellæ: canal central (*Sargus*, *Scomber*, &c.).
         β. Part of wall of ovary devoid of lamellæ; canal lateral. (Not yet observed.)
      2. Lamellæ parallel to transverse axis of ovary.
         α. With central ovarian canal (*Perca*, *Clupea*, &c.).
         β. With lateral canal (*Cyprinoids*, &c.).

Beyond the secondary egg-membranes, such as the gelatinous investment of the perch and allied structures, Brock considers that the egg has only one egg-membrane, the *zona radiata:* the existence of a true vitelline membrane he considers still an open question.

The tuft-like processes (Zöttchen) are merely secondary appendages of the zona radiata, and have nothing to do with either the follicular epithelium or with the yolk.

The yolk presents externally a "zonoid layer," which may be either entirely radially striated, or may be composed of an outer striated, and an inner homogeneous layer. The germinal vesicle has, except in the youngest eggs, a distinct, often somewhat crumpled, membrane, to the inner side of which the germinal spots are attached like knobs.

The paper concludes with some observations and remarks on the development of the egg and of the follicular epithelium.

Evolution of the Embryo in Eggs put to incubate in warm water.*—M. Dareste recalls the experiment of Réaumur, who, having placed eggs to hatch in warm water at the *incubating temperature*, found no vestige of the embryo. He renewed these experiments, and proved that the development had begun, but that the embryo had died at about the thirtieth hour, and had decomposed. In one single case, in which the embryo had not decomposed, it presented the monstrosity called "*omphalocephalic*": the heart, which was perfectly recognizable, was seen above the head, evidently arrested in its formation. In the vascular area there were no traces of vessels or blood.

Mechanical Genesis of Tooth Forms.†—In his articles on this subject Mr. J. A. Ryder has made a valuable contribution to the

* 'Comptes Rendus,' lxxxviii. (1879) p. 1138.

† 'Proc. Acad. Nat. Sci. Philad.' (1878) p. 45; (1879) p. 47. 'Am. Nat.' xiii. (1879) p. 446.

doctrine of evolution. He adopts the classification of teeth proposed by Cope, and endeavours to explain by mechanical laws the phylogeny of the various existing dental types pointed out by the same author. The application of mechanical theory to this question is ingenious, and results in some very probable hypotheses. First among these is the supposed effect of lateral pressure in flattening conical cones or cusps, so that their section becomes semicircular or crescentic. Another is the probable crowding of tubercles on each other by impact transverse to their directions, producing plicate structure.

A summary of his views is stated by the author as follows :—

1. The earliest and simplest type of mammalian jaw-movement was that in which the mouth was simply opened and closed, without mandibular excursion, and co-existent with the simple haplodont or binodont molar.

2. The development of the various kinds of excursion mandibular movement has apparently been progressive.

3. As the excursive movements have increased in complexity, there has been an apparent increase in the complexity of the enamel foldings, ridges, and crests.

4. From the fact that the foldings, &c., have apparently been modified in conformity to the ways in which the force used in mastication was exerted, it is concluded that the various modes of crest and tubercular modification are related as effects to the diverse modes of mandibular movement.

5. It is apparent from the facts presented throughout the context that the mandibular articulations, and correlatively the skull, have probably been modified in shape by the movements made by the jaws and the forces exerted in executing them.

6. From the fact that the incisor teeth are partially or entirely absent, or relegated to another function, in forms which have long prehensile tongues, mobile, prehensile lips or proboscides, it is held to to be probable that such disappearance of the incisive dental elements is due to the assumption of their function by the prehensile organs indicated.

Refractive Powers of Animal Tissues.* — We can only draw attention to the very valuable results attained by Professor Valentin, in which the ordinary blood, the menstrual blood, and the blood of the umbilical vein of man are examined, as well as those of a large number of animals; with these are connected a series of observations on the blood-corpuscles, on the influence of coagulation, and on the characters of the serum. The bile is also examined, as is the urine and the sperm; milk and other fluids, as well as albumen, are tested, while the brain itself, the lens, and muscular fibre did not escape examination.

Innervation of the Respiratory Organs.—The fourth number of the 47th volume (1879) of the 'Bull. de l'Acad. Roy. de Belgique' contains a memoir by Dr. Fredericq on this subject, together with a re-

* Pflüger's 'Archiv,' xix. (1879) p. 78.

port on the paper by M. van Bambeke. Dealing with the action of the peripheral nervous system on the centres of respiration, M. Fredericq points out the remarkable influence of the pneumogastric nerve; after describing his methods, a description of which would be out of place here, the author states that he has repeated the ancient experiment of Traube, in which it was found that in artificial respiration the original rhythm of the respiratory movements is adapted to the rhythm of the inspirations; but that when the pneumogastric nerves are cut this relation is lost. To complete this observation it was necessary to repeat the observations of Breuer, which in the words of M. van Bambeke "n'ont pas encore passé dans le domaine classique de la physiologie." These experiments tend to prove that there are in the pneumogastric nerve centripetal fibres, which arrest respiration in the stage of active expiration, and which are stimulated by the mechanical distension of the lung. M. Fredericq has been able to convince himself of the arrest of respiration in the expiratory stage; and the final conclusion is arrived at that there are centripetal fibres in the pneumogastric passing some to an inspiratory as well as some to an expiratory centre. Anatomy offers no aid in distinguishing these two sets of fibres, but it is found that chloral hydrate diminishes the action of the inspiratory fibres (or, rather, depresses the centre to which they go); when veritably poisoned by this drug every excitation, mechanical, chemical, or electric, arrests respiration in the expiratory stage, and it appears that this drug has, in large doses, the effect of slowing the respiratory movements till they disappear.

Ovary and the Corpus Luteum.*—The investigations of G. R. Wagener were chiefly made on the ovary of the bitch, though human subjects, moles, rodents, and other animals were also examined; the ovaries were, when possible, taken warm from the animal, and were, after division, placed in Müller's fluid, from which they were, after three days, removed to strong alcohol. On other occasions ovaries were examined, in the fresh state, in iodized serum.

The Epithelium.—This is placed over the whole of the free surface of the ovary, and is directly applied to the fibrous cortical layer; in its cells there may be observed rods which are set perpendicularly to the surface of the ovary. The nucleus, which is rounded, and presents a double contour, is very commonly of one size. There is, however, no epithelium over the point at which ova are escaping, or have escaped, and it is also absent in aged specimens. In the simple striated form there are a few larger cells, to which Waldeyer has applied the name of primitive ova; as to the *stomata* of the same author, it is said that they are mere spaces due to the incompleteness of the fusion of the cells

Cortical Layer.—The author points out that the arteries in this region are not of a large size, as some have supposed, and that their muscular layer can only be said to be strongly developed in proportion to the calibre of the vessels. As to the vexed question of the muscular character of the spindle-cells which so largely compose it,

* 'Arch. Anat. und Entw.' (His and Braune), (1879) p. 175.

the author states that he has observed a faint striation, and the regular arrangement of isotropic and anisotropic substances.

With regard to the ovarian follicle, we shall only observe that the abortion of the ovum is connected with the following phenomena:—The germinal spot disappears, and its place is taken by a small collection of angular and glistening waste products, or by a radially striated sphere formed of crystalline carbonates; the same fate awaits the germinal vesicle, and the whole of the yolk, but the *zona pellucida* may remain.

Corpus luteum.—The author, in examining a bitch, twenty-four hours after impregnation, found three large follicles in one ovary; from these, when opened, there escaped a small sphere of gelatinous matter, in which two ova were found. The walls of the follicle were seen to be very richly provided with vessels, and were thick; fourteen days after impregnation the vessels were found to be greatly increased in number and in size, and after twenty-one days the *corpus luteum* was found to be completely developed, and a number of "giant cells" were found in close proximity to the vessels; these accompany the vessels and gradually surround the cells of the *corpus luteum*, giving rise in time to fibrillæ, which convert the body into a *corpus albicans* or *nigricans;* they are, in fact, the rudiments of the fibrillæ of the connective tissue, and as they increase the cells of the yellow body undergo atrophy. Changes now occur in the contents of the blood-vessels which give rise to rusty brown aggregations, and the blood-vessels themselves die down. The surrounding tissues also suffer, and the wall of the follicle ceases to be apparent, while a whitish spot is at last all that is left to tell the tale of the changes that have taken place.

Natural Science Prizes, *Danish Academy.*—(Before 31st October, 1880. English allowed.)—(1) A series of comparative researches on the formation and development of the embryo sac and of the cells which it encloses before fecundation, made on a sufficiently large number of different angiosperms, so as to really increase the extent of our knowledge, bearing either on the law of development itself or on the general systematic importance of the differences which are presented, and to enable us at the same time to establish on a more solid basis than formerly the morphological value of the parts of the ovule.* (Gold medal of the Academy, value 320 crowns.)

2. Recent researches seeming to make it doubtful whether the salts of soda, so widely spread in the soil and in vegetable ashes, are really as necessary to the normal development of plants as the salts of potash, lime, magnesia, and iron, a research is required, which shall solve this question in regard to any wild and cultivated plants of Denmark.† (Thott prize, value 400 crowns.)

3. Original researches and experiments, which shall contribute to the elucidation of the development of the *Distoma* of the sheep, and that of their migrations until they arrive at the liver, as well as the

* Cf. 'Oversigt Danske Vidensk. Selsk. Forhand.' (1879) p. 28. ('Résumé du Bulletin,' p. 5.)

† Ibid., p. 6.

circumstances which may favour or hinder the introduction of the parasite into the sheep.* (Classen prize, value 600 crowns.)

Klein and Smith's Atlas of Histology.—This work (in 4to) is intended to be a pictorial and literal representation of the structure of the tissues of man and other Vertebrates; its chief aim being to teach, not so much the history of histology as histology itself in its modern aspect.

The plates are the work of Mr. Noble Smith and the text is by Dr. Klein. Both are excellent—the plates accurate and effective, the text clear and judiciously concise, and comprising besides the explanations of the illustrations a good deal of other matter.

The subject-matter will be treated in this order; first, the elementary tissues—blood, epithelium and endothelium, connective tissues, muscular tissue, the nervous, vascular and lymphatic systems; then a short chapter on "cells in general," after which the compound tissues will be considered seriatim; the alimentary canal and its glands, the respiratory organs, the urinary and genital organs, the skin and special sense organs. The concluding chapter will treat of organs, the nature of which is not sufficiently well known, as the suprarenal capsule, the thyroid and coccygeal gland.

B. INVERTEBRATA.

Fauna of Kerguelen's Land.†—The following are the chief conclusions to which Studer is led by his elaborate study of the fauna of Kerguelen's Land.

The fauna is similar to that of the other antarctic regions; it has numerous analogies with the arctic region; its most striking peculiarities belong to the terrestrial fauna, for of the marine genera only four are peculiar to it, while the other genera are found in New Zealand and Tierra del Fuego. It seems, indeed, that the southern point of America, the Falkland Islands, South Georgia, Prince Edward's Island, the Crozets, and Kerguelen must have been connected in earlier geological periods, and the great age of Kerguelen is spoken to by the characters of its geological formation.

Deep-water Fauna of the Lake of Geneva.‡—The fifth series of these interesting observations by Professor du Plessis commences with a note on the chemical characters of the mud of the lake, which, taken from three different stations, present some slight differences, but not such as to give any importance to the variations. As to the water, it is shown that there is no sensible difference in the amount of the solid matters dissolved in it at different levels; as to the gases, there is no great difference in their absolute amount, but, just as in the waters of the ocean, oxygen is greatly deficient and carbonic acid greatly in excess at great depths.

Professor du Plessis describes four *Turbellaria*, all of which are new to the fauna, and one of which is the representative of a new species—*Vortex intermedius*. Turning to the *Infusoria heterotricha*,

* Cf. loc. cit., p. 30 (p. 6.) † 'Arch. Naturg.,' xlv. (1879) p. 140.
‡ 'Bull. Soc. Vaud.,' xvi. (1879) p. 149.

the author draws attention to the scarcity of deep-water *Ciliata*. To get an exact idea of the *Heterotricha* found at great depths it is necessary to see how far they are represented in the fauna of the canton. The group of *Heterotricha*, which is characterized by the possession, in addition to short and regularly arranged cilia, of a spiral peristomial circlet of larger and stronger, setiform, cilia, may be divided into three groups—Spirostomida, Stentorida, and Bursarida. Of the first family, all the species have been found in the canton, with the exception of the marine genus *Condylostomum*; of the second, one genus, *Freia*, is marine, but the other, *Stentor*, is represented by all its species; while of the third group only two genera are free-living, and of these one only has been observed, and that in the person of its sole good species, *Bursaria truncatella*. The author states that of all these forms only five have been found on the shores of the lake, all of which, with the exception of *B. truncatella*, pass, without modifications, to the bottom of the lake, where therefore *Spirostomum ambiguum*, *Stentor cæruleus*, *S. polymorphus*, and *S. Röselii* have now been found. Of the *Rhizopoda*, for a long time not a single example was found. A dredging off Ouchy in the winter of 1877–78 revealed the presence of *Amœba princeps*, *A. terricola*, covered with its chitinous envelope, and *Difflugia proteiformis*, which by the production of gas in its interior is enabled also to live on the surface.

It is of interest to observe that specimens taken from the depths of the lake were found to be more transparent than those from the pools on the shore.

This instalment of the results of the explorations concludes with a list of the parasites and intestinal worms found in the fishes of the Lake of Geneva, prepared by M. Lunel.

"Liver" of the Invertebrata.*—M. Cadiat regards the Malpighian tubes of insects as belonging to the hepatic series, and points out that the large cells of which their walls are made up are separated from one another by spaces very similar to those which limit the cells of the hepatic lobule in the Mammalia; the green colouring matter which they contain exhibits with nitric acid the characteristic reactions of biliverdin. The liver of the Gasteropoda is stated to be broken up into lobules, which present an irregular central cavity connected with intracellular passages; the blood-vessels pass from the periphery to the hepatic lobule, and the biliary ducts take their origin from the central cavities of the lobules; the secretion is decolorized and dissolved by nitric acid and is regarded as a derivate of hæmatoidin in a different stage.

Mollusca.

Chromatophores of the Cephalopoda.†—The play of colour in the Cephalopoda was observed in the embryo, as well as in the adult, by Aristotle; later observers, such as Carus, delle Chiaje, and Wagner, have shown that this phænomenon is dependent on the possession and on the movements of the so-called chromatophores or pigment spots,

* 'CR. Soc. Biol.' for 1877 (1879), p. 217.
† 'SB. Akad. Wien,' lxxviii. (1879) p. 7.

which are scattered through the integument. It is to Kölliker, however, that we owe our first instalment of definite knowledge as to the structure of these bodies, inasmuch as it was he who directed attention to the presence of the radial contractile fibres, by the contraction of which the pigment spots are extended. A number of other observers have held similar views, and of these we need only refer to Brücke who pointed out the curious difference which obtains in the Cephalopod as compared with the chameleon; in the former the active state of the pigment spots finds its optical expression in their darker, while in the reptile it is in the brighter coloration. Other observers, such as Harting and Waldeyer, regard the play of colour as due to the protoplasmic substance of the chromatophore, and to that only. The question is now treated by Dr. Klemensiewicz, whose essay may be divided into two portions:—

Structure of the Chromatophore.—In this body we may make out the following parts: (1) A central pigment spot; (2) Its cellular envelope; (3) Radial fibres, set in a plane parallel to the surface of the integument and attached by their broadened conical ends to the pigment body; (4) The cavity of the chromatophore, which is separated from the dermal tissue by a thick layer of connective tissue. The examination of fresh specimens and of embryonic stages, together with specimens prepared by the aid of alcohol and gold chloride, has led the author to agree with Kölliker in regarding the pigment body as being a naked cell, for on no occasion has he been able to observe the structureless membrane described by Boll. As already stated, there is, however, a covering to the cell, which is partly formed by the *cellular* envelope described by Boll, and partly by the insertions of the radial fibres; in the contracted state this investment forms a hollow sphere with outwardly projecting processes; it consists of several layers of cells, between the elements of which there pass the insertions of the radial fibres. No very definite results were attained to with regard to the disposition of the nerve-fibres, as the author was not able to make out any direct connection between them and the pigment body or the radial fibres; the question is however one of very great difficulty from a histological point of view, but we shall see directly how great is the connection which can be made out by the physiological method of investigation. As to the coloration of the chromatophore it is now known that this does not only differ in different species, but even at different stages in development; thus in *Loligo vulgaris* it is reddish in the embryo, but violet in the adult. Of course, also, it differs in different stages of contraction, and thus while it is violet when expanded, it is dark brown or black when contracted; the form too is different, for the thin plate seen in the expanded stage is brought into a more or less rounded form in the contracted condition of the chromatophore. The radial fibres similarly differ in form, being thin and lamellar when the chromatophore is contracted, but broader when it is expanded; they are enclosed in a fine structureless membrane. The cavity (4) is chiefly filled with fluid. The histological differentiation of the body may be shortly summed up in saying that the pigment-spot is formed of a single cell,

and that the protoplasmic mass in which it is imbedded goes to form the cellular investment and the radial fibres.

Physiological Experiments.—These leave no doubt as to the influence of the nervous system on the chromatophores, and are of great interest. Using chiefly *Eledone moschata*, the author shows that there are fibres in the nerves of the arms, mouth, and funnel, which, when stimulated, bring about a darkening of the integument; these nerves are connected with the pedal and visceral ganglia and with the median portion of the lower half ring, which is known to be in connection with the optic ganglion, and there is in this region, it is believed, a special centre for the stimulation of the chromatophores; the results of section of the optic nerve and observation on the changes which obtain when the animal is in the presence of different colours, leads to the view that the chromatophores may be stimulated, after a reflex mode, by the influence of light on the eye. It is also probable that changes may occur at the will of the animal, and support is afforded to this view by the statements of Colosanti with regard to the "nervous axis" of the arms of the cephalopod, which appears to have the structure of a central organ; finally, changes occur when the integument is stimulated, whether mechanically, chemically, or electrically.

The author concludes with some remarks on the "mechanics" of the movements of the chromatophores; here the cardinal point is that when *active* the structures in question are *expanded*, and when *passive* are *contracted*. The opposite condition in the chameleon and certain fishes is to be correlated with the absence, in them, of the system of radial fibres; but this is not the whole difference, for in the Vertebrates just mentioned the changes in colour may take even hours to be effected, while in the fresh cephalopod they occur with extraordinary rapidity. A further proof of the value of the radial fibres is afforded by the fact that in the embryonic condition of the chromatophore the separate fibres may be seen to move; and it may well be concluded that the extension of the chromatophore is due to the contraction of all the radial fibres, which moreover always move in *straight* lines and never exhibit the looped arrangement which they necessarily would, if they were as some have supposed, nerve-fibres passing to the contained protoplasmic mass. The subsequent contraction of the chromatophore appears to be principally, though not altogether, due to the elasticity of the cellular investment, and the rapidity with which it is effected is well explained by the supposition that we have to do with what is practically a weighted muscular fibre; fixed at one end to the skin, there is attached to its other end the movable mass of the chromatophore, where the elastic force of the investment and the contractility of the pigment body represents the weight. The author expresses his belief that nerves pass to the separate radial fibres, although the presence of these has not yet been demonstrated.

There is an account of a few experiments with poisons; no effect was observed with curare.

Shells of the Cephalopoda in relation to the Body of their Constructor.*—Professor Owen returns with new arguments and fresh

* 'Proc. Zool. Soc. London' (1878) p. 955.

vigour to the defence of the position which he took up a number of years ago, as to the difference in the characters of the coil of the shell in *Spirula* on the one hand, and *Nautilus*, with the Ammonites, on the other; the latter are regarded as revolutely spiral or coiled over the back of the animal, whereas those of *Spirula* are involute.

It has long and well been known that the "fossil shells of Cephalopods exhibit a progressive uncoiling from *Nautilus* to *Orthoceras*, and from *Ammonites* to *Baculites*," but, as Professor Owen well remarks, anatomical evidence was required to demonstrate that there had been coiling in the reverse direction; that has been supplied by his dissections of *Spirula* and of *Nautilus*, and the author now demonstrates that it is not always necessary to have seen an animal before we are able, with proper insight, to tell a very great deal about its organization. Applying this to the Ammonite, we find evidence in support of Owen's long-held view as to the shells of these animals having been external; while specimens in which injury and repair have been effected point to the mantle of these forms having had just the same structure as in the living *Nautilus*, and as having been applied to the shell, and not to have been "muscular and inapplicable to the last chamber as in *Spirula*." Another point of similarity between the first two of these forms is that the shell is porcellano-nacreous in structure, and not simply nacreous as in *Spirula*. Between *Spirula* and *Ammonites* there is, however, a very remarkable similarity; in both, the siphons in the shell are *ventral*, or *ventro-marginal*, but in relation to the curves of the shell, the siphon of *Spirula* is "internal" or "ento-marginal," whereas in the Ammonitidæ it is "external" or "ecto-marginal." To turn to the Nautilidæ, where the siphon is central or subcentral in most cases; in others (rare) it is ecto-marginal, and still more rarely it is ento-marginal. It is here of interest to observe that it may change its position as it passes through the different chambers of the shell, so that the position, which is a sign of immaturity in the existing *Nautilus*, was longer retained in the old Tertiary species.

Professor Owen deals also with the history of those curious structures, which under the names of *Trigonellites*, or *Aptychus*, have been referred to the Cirripeds, or have been regarded as parts of the Ammonite's gizzard, or as protective plates of the nidamental glands in the female; a careful discussion of the question leads the author to accept and support the view held by Van der Hoeven, that the shells in question formed two shelly supports for the hood of *Ammonites*.

Turning to the chambers of the shell, Professor Owen next describes what obtains in *Vermetus gigas* and in *Spondylus varius*, as well as what is seen in *Spirula* and *Nautilus*. As to the "final cause" or function of the chambers, the author holds to his original opinion that they enable the *Nautilus* to rise, and the *Spirula* to sink. As to the modes by which the shell may become complicated, it will be of interest to note that the septa may be (1) simple and distinct, attached only by their circumference, or (2) attached subcentrally to each other as well as by their circumference to the shell-wall; or (3) attached marginally to the shell-wall and having an organized vascular mem-

branous canal contained in a testaceous tube which unites the partitions; or (4) the tube may be replaced by a number of superimposed funnel-shaped tubes; or, lastly, the tube may be interrupted and the septa and chambers be traversed by a lime-coated membranous canal. With regard to the last arrangement, which is that which is found in the *Nautilus*, it is to be noted that the "calcareous incrustation is apt to be dissolved by the acetous change of the alcohol," and it is this which gives especial value to the observation of Professor Vrolik, inasmuch as it had been previously supposed by some that the siphon of the *Nautilus* might have a dilating and contracting action. The paper concludes with some remarks on the vascular supply of the siphon, and with some suggestions to the student who shall be fortunate enough to be able to examine these forms in their living state.

Eye of the Cephalopoda.*—Dr. Schobl, in an article on this subject, deals more especially with the vascular supply, in addition to which he gives an account of what has been done by earlier authors; as will be gathered from the few words we can say, the arrangements are difficult to make out in their completeness. Around the cornea there is a pair of greatly coiled arteries, and of veins; outside these there is a fringe, in which are small veins and arteries, and outside this is the *circulus arteriosus iridis*; this last is bounded by a fairly broad *corona ciliaris*, made up of about 160 closely applied ciliary processes. Then there is a ring of well-developed vessels formed by a median artery with a vein on either side; then the ciliary plexus, and the well-developed posterior ciliary vein and artery. External to the circular vessels we find the *zona ciliaris*, in which are a number of *venulæ* and of "recurrent arteries."

Action of Strychnine on Gasteropodous Molluscs.†—Mr. E. Heckel has presented to the Academy of Sciences an account of the action of the salts of strychnine upon these Molluscs.

Noting the fact that the alkaloids occur more frequently, and possess a more powerful physiological activity, the higher we ascend in the scale of vegetable life, he asks whether their special task may not be to defend the plant against animal enemies, especially as the more important an organ the more generally it is possessed of poisonous properties. He therefore finds it important to ascertain the action of the best-known alkaloids upon certain selected terms in the animal series. For this purpose he has experimented with strychnine sulphate and oxalate upon *Helix pomatia* and *aspersa*, and *Zonites algirus*. He observed that whilst *Helix aspersa* of the mean weight of 6 to 6·70 grms. succumbed to a dose of strychnine sulphate of ·025 grm., *Zonites algirus* of 8 grms. and *Helix pomatia* of 9·70 grms. perfectly resisted doses of ·045 grm. He concludes that the Gasteropods enjoy a remarkable immunity from the effects of strychnine; that with them, as in the case of the Vertebrata, the degree of

* 'Arch. Mikr. Anat.,' xv. (1878) p. 215.

† 'Comptes Rendus,' lxxxviii. (1879) p. 918; 'M. Journ. Sci.,' i. (1879) p. 514.

hurtfulness of the poison is inversely as the weight of the animal, and that upon them, as in higher animals, strychnine is tetanizing.

Animal of Voluta musica.*—M. P. Fischer, having examined a specimen from Guadeloupe, preserved (imperfectly) in alcohol, finds that it differs from all the other species of this great genus, by its operculum much more elongated than that of *Lyria* and by its multicuspid lingual plate, and considers that it would be better to abandon the name of *Voluta* and substitute *Musica*. It approaches *Vespertilio*, *Amoria*, &c. (of the Volutidæ without operculum) by the greater part of its exterior characters, *Lyria* by the existence of an operculum, and *Marginella* by its lingual plate. It constitutes therefore a well-defined group, which should remain with the Volutidæ, of which it is one of the most aberrant forms.

Neomenia (Solenopus).†—The Rev. A. M. Norman says that the type species has long been known to him as an inhabitant of the British Seas (Shetland). The genus and species must he thinks in justice bear the name (*Neomenia*) bestowed by Tullberg, who published an accurate description, with two plates of figures of the animal and its anatomy, in 1875, at a time when M. Sars had only given the MS. name.

Two Collections of Pteropoda.‡—Dr. G. Pfeffer contributes an account of the Pteropoda collected by the German corvette 'Gazelle,' and by Herr Jagor in the Philippines; one new genus, four new species, and a well marked variety are here described for the first time. More attention is paid in the descriptions to the characters of the shell and of the larval shell, as seen by a hand-glass, than was given to the subject by Rang and Souleyet. The paper, which is purely technical and quite beyond any abstract, is illustrated by one plate.

Respiratory Apparatus of Ampullaria.§—M. Jourdain describes the results of his examination of four of these interesting Mollusca from Mexico. The respiratory apparatus, which is placed as usual in the pallial chamber, has the gill on one (the left) side largely atrophied. Between it and the normally developed gill there is the pulmonary pouch, which is formed, apparently, by a fold of the mantle, and is separated by a groove from the right gill; on the floor of the chamber there are developed two siphon-like folds, one of which is large and connected with the pulmonary sac, and the other small and related to the well-developed gill. The renal gland is placed behind this latter structure. In describing the relations of the vessels the author points out that a large number of veins ramify in the walls of the pulmonary pouch, while the blood from the atrophied gill returns to the pallial vessels, to pass to the proper respiratory apparatus.

* 'Journ. de Conchy.,' xix. (1879) p. 97.
† 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 164.
‡ 'MB. K. Preuss. Akad. Wiss.' (1879) p. 230.
§ 'Comptes Rendus,' lxxxviii. (1879) p. 981.

Molluscoida.

New Genus of Polyzoa.*—The Rev. J. E. Tenison-Woods describes *Euktimenaria ducalis* (εὐκτίμενος, well-built) as a very interesting and curious genus dredged at a depth of 10 or 20 fathoms on coral mud off Darnley Island. It differs so completely from any of the described families of the Cheilostomata that its affinities and relations must remain problematical until others are discovered. The nearest family is the Selenariadæ which have the polyzoary more or less orbicular, convex on one side. Its singular beauty both as regards design and ornament renders it a remarkable addition to an order where beauty and variety are the rule.

The genus is characterized thus:—Polyzoary free, upper surface convex covered with cells, lower surface divided into five portions, each containing large pores; in the centre of the base a vermiculate quinque-partite body.

The species is convex with pentagonal outline; the edge circumscribed by a raised margin of five arches, whence it descends to a broad pentagonal pedicel by five arched concave surfaces, which are horizontally divided in the centre by a straight raised double ridge, above and below the centre of which there is a large conspicuous pore; the pore above is semicircular, that below is perfectly round; both seem deep. The margin of each of the arched spaces curves round into a loop at each side below the lower pore, and is curved again in a contrary direction at each side so as to form another small loop in which there is another small pore. Beneath the lower of the two large central pores there are one or two conspicuous grooves to the base. Upper convex surface covered with concave cells, with a distinct raised margin; mouth in the centre, semicircular, with a raised margin. Shape of cells from oval to circular, a few almost pentagonal; the centre of the convex surface seems covered with cells but they are worn almost smooth on both the specimens. The base is vermiculate, but with a radiate tendency, and forming a quinque-partite pattern. Between the margin of the five sides there are upper and lower angular spaces, giving great elegance to the design.

Dimensions: alt. 6, diam. of summit 8, of base 4½, lat. of five lateral spaces 4½, alt. 3¼ mm.

The author is unable to suggest any explanation of the pores on the sides or the organs which form the margins, transverse bands, &c. It is quite evident that there must be some individuality in these zoothomes apart from what we call the animal which dwells in the cells, or the symmetrical arrangements of the species could not be explained.

Embryology of Tendra zostericola.†—In continuation of his researches into the history of this form Herr Repiachoff now gives some few details as to the stages subsequent to the blastula; in which there is to be observed a slight thickening of the ectoderm, on the ventral surface; this becomes gradually more marked and is evidently

* 'Proc. Linn. Soc., N.S.W.,' iii. (1878) p. 126.
† 'Zool. Anzeiger,' ii. (1879) p. 67.

the rudiment of the sucker, the cavity in which is formed by a process of invagination; the apparatus is purely ectodermal in origin.

The upper part of the body, or that which, in the larva, contains the oral groove is, at first, relatively very small; increasing in length later on, it becomes connected with the endoderm and comes into contact with the fore-gut; still later the portion of the endoderm which lies superiorly to the fore-gut separates from the rest of the endoderm, and becomes fused with the gut, and now forms a collection of cells which becomes closely applied to the oral grove. The author refrains from entering at present into a full discussion of theoretical considerations.

Arthropoda.

Metamorphoses of the Blister Beetle (*Lytta vesicatoria* Fab.).*—M. J. Lichtenstein has succeeded at last in following the complete development of the blister-beetle from the egg to the perfect insect, which had already been done for *Meloe*,† *Sitaris*,‡ and *Epicanta*,§ but had never been accomplished with the blister-beetles. The author reserving to himself the publication of his entire memoir in the special entomological journals, communicates a *résumé* of his work to the French Academy.

He placed females which had copulated towards the end of May and the beginning of June, under a bell-glass with some earth, in which the female laid its rather elongated, whitish, and transparent eggs. In a fortnight the larva long known under the name of *Triungulinus*, issued from the eggs. It was scaly, and dark brown, with the meso- and metathorax and the first abdominal segment white. It had very acute jaws, black prominent eyes, and two long caudal setæ.

The author, after several fruitless trials, fed the larva on the stomachs of honey bees, and then on the eggs and young larvæ of bees—*Osmia* and *Ceratina chalcites*. Honey must be added to the eggs or young larvæ, as animal food is only fitted for this first larval form, and the little *Triungulinus* has an instinctive knowledge that it must not touch the eggs or larvæ unless there is enough honey to feed the form which is to follow it.

On the fifth to the sixth day it changed its skin, lost its caudal setæ and brown colour, and became a small white hexapod worm; its sharp jaws became obtuse, its eyes less brilliant, and it left the eggs and young larvæ and ate honey. Five days later it again changed its skin, it jaws became still broader, and its eyes further obliterated.

Five days later there was a fresh moult. The eyes now disappeared entirely, the feet and jaws became brown and horny at the extremity, the insect presenting the appearance of a small larva of a *Scarabæus*, and it is seen that it is destined to burrow in the earth.

* 'Comptes Rendus,' lxxxviii. (1879) p. 1089.

† Newport, "On the Natural History of the Oil-Beetle (Meloe)," in 'Trans. Linn. Soc. Lond.,' 1861.

‡ Fabre, "On *Sitaris humeralis*," in 'Ann. Sc. Nat.,' 1857; Valéry-Mayet, "On *Sitaris collatis*," in 'Ann. Soc. Entom.,' 1875.

§ Riley, in 'Trans. Ac. Sci. St. Louis,' 1877.

So far the author had reared them in small glass thimble-shaped tubes, corked and placed upside down, the observations being followed on the surface of the cork. In order to supply the necessary earth in a sufficiently damp state for the larvæ, he now used a glass tube ·10 m. in length by ·025 in diameter, stopped at the bottom by a piece of sponge, and filled with earth, on which he placed the "scarabæoid" larva (this word has already been used by Riley for *Epicanta*). It immediately buried itself, and formed, a little above the sponge, a small chamber or cavity against the wall of the tube, which enabled even its subterranean movements to be followed. In five days more there was a fresh moult; but this time it was no longer a larva that appeared, but a pupa, like that of a Muscide, having four small mamillæ at the apex, and three pairs of small ones in the place where the legs were. It was horny-white in colour, and motionless, having the appearance of a chrysalis. This condition lasted all the winter, and one would have thought life was quite extinct, if from time to time it had not squeezed out of its pores small drops of a transparent hyaline fluid, which remained for several days on the surface of its body.

On 15th April this pupa burst its envelope, and gave issue to a white grub very similar to the *scarabæoid*, but without the strong claws and jaws; only showing rudimentary feet, each composed of three short, thick pieces. This grub moved slowly in its cell; it did not quit it and did not eat. On 30th April there was a fresh moult, giving at last a nympha, returning to the regular coleopterous type, with all its limbs quite visible. This nympha, at first white, soon became coloured. On 17th May it was already of a dark hue, and on 19th the beetle was seen in the tube with its brilliant covering.

The complete evolution of the insect thus lasts for about a year.

The author strongly suspects that those bees which make nests in the earth, like *Halictus* and *Andrena*, are the usual prey of these insects, but has not yet made exact observations on the subject.

New Genus of Cochineals of the Elm.* — M. Lichtenstein has also discovered a new and very strongly-marked genus of cochineal living on the elm, forming the transition between the Coccidæ and Phylloxerians, which he has named *Ritsemia*, after M. C. Ritsema, the Curator of the Leyden Museum.

The animals, first observed in August, were red, ·45 mm. long, of an elongate-oval form, with six-jointed antennæ. Attaching themselves in the crevices of the bark of *Ulmus campestris*, they lost their aphis-like form and took that of a small, flattened, reniform gall or vesicle, as in many Coccidæ. At this period they approached the genera *Nidularia* and *Gossyparia* as they exuded a cottony mass underneath, in which they deposited ovoid bodies of different sizes, which are not true ova, but analogous to what the author has called *pupæ* in the Phylloxerians. In March these bodies acquired traces of segmentation, and in April the males issued from the cottony mass. Their antennæ, moniliform and of nine joints, resemble those of the Coccidæ,

* 'Comptes Rendus,' lxxxviii. (1879) p. 870.

but in other respects the form is not that of the male Coccidæ, but of the Phylloxerians. The head, thorax, and abdomen are united and not separated, as in the former. They are ·4 mm. long, completely apterous, without a rostrum, and with a projecting penis.

A few days after the appearance of the males the pupæ remaining in the cottony mass developed and furnished the female, ·45 mm. long, very similar to the form that appears in August, except that it has eight joints in the antennæ instead of six, and is therefore a different phase. Copulation takes place at the time.

M. Lichtenstein has not yet been able to follow what takes place between May and August, and calls attention to the fact that while these insects exist "in millions" on every elm, the problem of the complete cycle of their life-history, which was set by Réaumur, is still unsolved.

The specific name of *pupifera* is given to call to mind the mode of reproduction (*Anthogenesis*) in which there intervenes a form furnishing male and female pupæ from which the sexual individuals issue and immediately copulate.

Notes on the Phryganida.*—Fritz Müller draws attention to the fact that the pupæ of the *Helicopsyche*, which are found in the brooks around him (Blumenau, Brazil) have the first four appendages long and more or less richly ciliated; in those, however, which are found by the waterfalls, and live on damp stones, the hairs are absent. These examples appear to be of importance as they show in a very striking way the fact that the reduction of parts which have become useless must not be looked upon as being in all cases the simple and direct result of disuse. These swimming hairs are connected with the membrane of the pupa, which covers in the mature insect, so that their being or not being used seems to be a point which would have but slight, if any, effect on the descendants of the insect; why, then, do they disappear so suddenly when the animal changes its locality to one in which it does not swim, and yet why are such useless parts as the incisors in the upper jaw of the ruminant, which are never cut, continued on generation after generation? The answer seems to lie in the difference of time that these separate structures have been in the possession of the animal; where they have been lately acquired, they are, on disuse, easily lost; but where, as in the case of the ruminant's upper incisors, transmission has been acting for long ages, disuse does not so easily or so rapidly effect complete loss of the now useless structures.

Anatomy and Physiology of the Digestive Organs of the Myriapoda.†—M. Felix Plateau, in continuation of his researches into the digestive apparatus of the Insecta, now presents a memoir on the Myriapoda, concerning which group the remark of Newport, made more than thirty years ago, "The Myriapoda have been more neglected by naturalists than almost any other division of the Articulata," still remains true.

* 'Zool. Anzeiger,' ii. (1879) p. 180.
† 'Mém. Acad. Roy. Sci. Belg.,' xlii. (1878), Art. ii.

The digestive tube in this group is more like that of the Insecta (Hexapoda), than to that of any other Arthropod; it consists of a buccal, a median, and a terminal portion, and is provided with a pair of salivary glands, and with one or two pairs of Malpighian tubes; the buccal intestine may be short and broad (*Julus*), or very long and capacious (*Cryptops*), or very long and excessively narrow (*Geophilus*); the epithelium may be absent from its walls, and the chitinous cuticle is in a few cases (*Lithobius*) provided with short chitinous projections which are directed backwards; in *Cryptops* there is a false gizzard intercalated between the fore and the median intestine, which is very muscular, and is provided with a number of setæ or chitinous spinules. The terminal portion of the intestinal tract is ordinarily short, but is elongated in the Chilognatha (herbivorous forms), and is longest in *Glomeris*; the following table will indicate the variations in its disposition, concerning which it was stated by the late and lamented Gervais, that it was only coiled in *Glomeris* and its allies:—

Greatly coiled	Coils occupying a large extent of the cavity ..	*Glomeris.* *Zephronia.* *Sphærotherium.*
Greatly coiled	Coils occupying a small extent	*Cryptops.* *Himantarium.* *Geophilus.*
Simple terminal curvature		*Julus.*
No convolution or curvature		*Lithobius.*

This terminal portion is always richly supplied by tracheæ.

The salivary glands may be racemose (*Lithobius*, *Cryptops*) or tubular (*Julus*, *Glomeris*); in *Geophilus* the excretory canal (efferent duct) is very long, but in *Julus* and *Glomeris* it is short. The Malpighian tubes, which are inserted into the point at which the median passes into the terminal intestine, are ordinarily two in number, but *Julus* has four; they may be of the same diameter along their whole length, or be dilated into reservoirs (*Lithobius*, *Geophilus*). By transparent light they are seen to be of a yellow colour, and their secreting cells are much smaller than in most insects.

Examined physiologically, we find that the *Myriapoda* may be carnivorous or herbivorous; the former, or Chilopoda, live on flies, earthworms, spiders, larvæ, and so on, which they seize between their forcep-like foot-jaws, and poison; the effect of the poison of *Lithobius* on the house-fly is reported to be as rapid as the bite of the spider; the victim, so soon as it is killed, is devoured rapidly, everything being swallowed, either in large (*Lithobius*) or in minuter (*Geophilus*) mouthfuls. The herbivorous forms (Chilognatha), live on decomposing vegetables (*Julus*), decayed wood (*Polyxenus*), or moss (*Glomeris*), which they gnaw; and in swallowing their food they, like the Chilopoda, take in some, though not so much, earth or sand. In *Cryptops* the gizzard already mentioned delays the food, which is, in it, subjected to the action of a digesting fluid of neutral reaction. In most cases digestion proper is effected in the median portion of the intestine, where the food is acted upon by a yellowish or brownish liquid secreted from its walls; this is ordinarily neutral, but in *Lithobius*,

Cryptops, and others it is faintly alkaline; while the Julidæ are remarkable for having an acid secretion. After this, digestion seems to be at an end in the carnivorous forms, as is shown not only by the extreme shortness of the remainder of the digestive tract, but by the fact that the excreta are enclosed in a fine membranous envelope, which is formed in the median intestine, and which is capable of very effectively resisting the action of chemical agencies; this fæcal membrane is absent in the herbivorous forms, who have, as we now know, a somewhat coiled terminal portion.

Julus and *Himantarium* are shown to resemble a number of insects in resisting for a long period the effects of starvation. The secretion of the buccal glands is colourless, and is neutral or slightly alkaline in reaction; it is never venomous, nor is it similar to the true saliva of Vertebrates or Insects inasmuch as it is incapable of converting starch into glucose. The Malpighian tubes seem to be exactly similar to those of the allied Insecta, and to have the same function of depuratory urinary organs; they produce uric acid, urates of sodium, &c., and oxalate of calcium. This important memoir is illustrated by three plates.

New Scolopendra.*—Professor Giebel gave an account to the Naturw. Verein in Halle of a new Scolopendra, discovered in Ecuador, for which the specific name of *respublicana* is proposed; most nearly allied to the *S. insignis* from Columbia of Gervais it differs in its smaller size, the coloration of the upper surface, which is olive-green in the new species, and the armature and number of spines on the legs, of which it has twenty-one pairs; there are nine pairs of stigmata.

Pentastoma tænioides in the Ear of a Dog.†—Dr. Gillé presented a specimen of this organism which he had taken from the middle ear of a dog; he observed that the mucous membrane was greatly thickened and inflamed; the "worm" (Linguatulid—one of the Arachnida, as ordinarily regarded) must have entered by the Eustachian tube, and indeed another and smaller specimen was observed in the nostrils. The creature is ordinarily reported as inhabiting the nasal fossæ, the frontal and ethmoidal sinuses, and the region now recorded is one in which it has not been hitherto found.

Genera of Acari.‡—Dr. Kramer gives a careful history and critical account of the genera *Rhapignathus* of Dugès, *Leptognathus* of Hodge, and *Caligonus* of Koch. *R. ruber* of Koch has not the slightest resemblance to *R. ruberrimus*, while the genus *Caligonus* which this latter author subsequently founded for the species, is too slightly described for accurate or certain recognition. After referring to the work of Canestrini and Fauzago, who appear to have put the forms in question in a more natural position in the system than any they had before occupied, the author goes on to refer to the work of Mr. Hodge who formed the new genus *Leptognathus*. The author in proceeding to

* 'Zeitschr. Ges. Naturw.,' lii. (1879) p. 326.
† 'CR. Soc. Biol.' for 1877 (1879), p. 394.
‡ 'Archiv Naturg.,' xlv. (1879) p. 142.

give an account of the genera states that he has not seen the works of Hodge, and does not know whether he gives any diagnosis of the genus. The writer of this notice has made it his business to refer to the 'Trans. of the Tyneside Nat. Field Club,' in which Mr. Hodge's paper appeared, and finds that, after the notice of the species, the writer says that from the "peculiar character of the rostrum, absence of true palpi, and number of eyes, it would appear to form the type of a new genus," without any more definite diagnosis. The paper concludes with a short account of a new genus *Cryptognathus*, and of the species *lagena*; it is illustrated by a plate of fifteen figures.

The Nebaliad Crustacea as Types of a New Order.* —The *Nebaliadæ*, represented by the existing genus *Nebalia*, have generally been considered to form a family of Phyllopod Crustacea. Metschnikoff, who studied the embryology of *Nebalia*, considered it to be a "Phyllopodiform Decapod." Besides the resemblance to the Decapods, there is also a combination of Copepod and Phyllopod characteristics. The type is an instance of a generalized one, and is of high antiquity, having been ushered in during the earliest Silurian period, when there were, when we regard the relative size of most Crustacea, and especially of living *Nebaliæ*, gigantic forms. Such were *Dithyrocaris*, which must have been over a foot long, the carapace being seven inches long. The modern *Nebalia* is small, about half an inch in length, with the body compressed, the carapace bivalved as in Limnadia, one of the genuine Phyllopods. There is a large rostrum overhanging the head, stalked eyes, and besides two pairs of antennæ and mouth parts, eight parts of leaf-like, short, respiratory feet, which are succeeded by swimming feet. There is no metamorphosis, development being direct.

Of the fossil forms, *Hymenocaris* was regarded by Salter as "the more generalized type." The genera *Peltocaris* and *Discinocaris* characterize the lower Silurian period, *Ceratiocaris* the upper, *Dictyocaris* the upper Silurian and the lowest Devonian strata, *Dithyrocaris* and *Argus* the Carboniferous period. Our existing northeastern species is *Nebalia bipes* (Fabricius) which occurs from Maine to Greenland.

The Nebaliads were the forerunners of the Decapoda, and form, we believe, the type of a distinct order of Crustacea, for which the name *Phyllocarida* is proposed.

Physiology of the Nervous System of the Crayfish.†—Mr. James Ward, M.A., gives a brief account of experiments, consisting mainly in severing (1) one or (2) both of the supra-œsophageal commissures, (3) both the sub œsophageal commissures, or (4) in dividing the supra-œsophageal ganglia longitudinally.

From these experiments it may perhaps, with more or less probability, be inferred that :—

(*a*) There is no decussation of the longitudinal fibres in the nervous system of the crayfish.

* 'Am. Nat.,' vol. xiii. (1879) p. 128.
† 'Proc. Roy. Soc.,' xxviii. (1879) p. 379.

(b) On the presence of the supra-œsophageal ganglion depend (1) the spontaneous activity of the animal as a whole, or what might be called its volitional activity; (2) the power to inhibit the aimless and wasteful mechanical activity of the lower centres; (3) the power to maintain equilibrium; and (4) the use of the abdomen in swimming.

(c) The sub œsophageal ganglia are the centres for coordinating (1) the locomotive, and (2) the feeding movements, and (3) for a peculiar rhythmic swim of the limbs seen as soon as the supra-œsophageal ganglia are removed (the sub œsophageal ganglion is apparently the source of a considerable amount of motor energy).

(d) There is much less solidarity, a much less perfect *consensus*, among the nervous centres in the crayfish than in animals higher in the scale. The brainless frog, e. g., is motionless, except when stimulated, and even then does nothing to suggest that its members have a life on their own account; whereas the limbs of a crayfish deprived of its first two ganglia, are almost incessantly preening, and when feeding movements are started, the chelate legs rob, and play at cross-purposes with, each other as well as four distinct individuals could do.

(e) Some stimulus from other centres is more or less necessary to the activity of any given centre.

(f) The "natural" discharge of a ganglionic centre (not exhibiting "volition") appears to be of a rhythmic kind; the rhythmic movements becoming converted into varied movements by temporary augmentation or inhibition.

Influence of Heat on the Nervous Centres of the Crayfish.*—M. Richet commences by describing an experiment, by which he says the state of the nervous centres which preside over the power of movement may be well tested. If a healthy crayfish is held by the back between two fingers, it attempts to seize objects between the two branches of its pincers, and if the edge of the inner one be lightly touched the two parts are immediately brought together. Regular as this action is, it is not purely reflex, for in the water the crayfish does not act in the same manner; instead of trying to seize its aggressor, the animal may attempt to escape. Of the true reflex acts three are taken as examples. When the antennæ are cut or pinched, the animal withdraws them; when the eyes are touched, their supporting pedicels are retracted. Section of one of the large pincers produces swimming movements, to the number of five or six, of the caudal appendage.

Now in submitting a crayfish to high temperatures, the different functions of the nervous system are seen to disappear, one by one, as the temperature is raised:—

1. 23°–24°: The pincer is most feebly moved; or the voluntary nervous system is affected.

2. 24°–26°: No movement of the pincer under the conditions of the experiment above detailed; or complete loss of voluntary nervous activity.

* 'Comptes Rendus,' lxxxviii. (1879) p. 977.

3. 27°–29°: Reflex action disappears, although the muscles and nerves still react on electrical excitation.
4. 32°–34°: Motor nerves become inactive.
5. 33°–36°: Muscular tissue ceases to display its properties.
6. 37°: Muscular tissue altogether dead, in a state of contraction.

Temperatures higher than 32° were found to be mortal. The nerves which govern the respiratory movements lose their powers when subjected to a heat of from 28° to 30°.

Blood of the Lobster.*—Dr. Léon Fredericq agrees with MM. Jolyet and Regnard in finding two colouring matters in the plasma of the lobster's blood; one, of a rosy hue, is with difficulty diffusible, and is not coagulated by boiling or by alcohol, nor does it contain any metallic salt. It does not change colour in vacuo, or under the action of oxygen, nor is it invariably present. The other appears to be identical with the blue colouring matter hæmocyanin,† which the author has already found in the *Octopus*. The blood of the lobster, when these two constituents are present, is rosy on reduction, while when exposed to oxygen it is blue by reflected, and brown by transmitted light; it coagulates rapidly after removal from the body. The colour of the blood of *Limulus*, as lately described by Professor Ray Lankester, seems to Dr. Fredericq to point to the presence therein of hæmocyanin, which has been distinctly found in some Gasteropods.

Observations on the Amphipoda.‡—Professor Wrześniowski describes four new species of the genus Hyale from Peru, and points out that the genus may be divided into two subgenera, *Allorchestes*, in which the telson is simple and has a complete margin; and *Hyale* proper, in which the margin of the telson is more or less cleft.

Contributions to the Natural History of the Caprellidæ.§—Herr Gamroth deals with this "cosmopolitan" group of the *Amphipoda*; the specimens for his examination were obtained at Trieste, where he found them seeking quiet in the branches of a bryozoon (*Bugula neritina*) to which they adhere by their hinder thoracic appendages.

That which has been least studied is the internal organization.

Their muscular system is exceedingly well-developed, and consists of longitudinal muscles, which effect the movements of the body and of the well-developed antennæ, and of transverse muscles which move the appendages and the digestive apparatus in its more anterior region. As in all allied forms the muscles are transversely striated.

The nervous system consists of a cerebral ganglion and a ventral chain connected with it by two commissures; the lower part of the former is continued into four conical processes, each of which gives off a large nerve-trunk; the upper and larger portion is divided into two rounded lobes, which are continued backwards into two broad commissures; then succeed five ganglia, of which the first four are similar in form and size; the last ganglion is larger, and this is

* 'Bull. Acad. Roy. Sci. Belg.,' xlvii. (1879) p. 409.
† This Journal, ii. p. 164.
‡ 'Zool. Anzeiger,' ii. (1879) pp. 175 and 199.
§ 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 101.

apparently due to the fact that it supplies the sixth and seventh segments and the rudimentary abdomen. The eyes, which are without stalks, lie at the sides of the head and have a few pear-shaped crystalline cones imbedded in a brownish-red pigment; the tactile organs are represented by setæ, which are especially well-developed on the flagellum of the superior pair of antennæ; as in most *Amphipoda* there is no distinct auditory organ; on the same flagella are found delicate white bodies, which are evidently olfactory in function. The *frontal organs*, which seem to be found in all other *Amphipoda*, are here also found; paired and lying just behind the root of the superior antennæ, they are goblet-shaped in form, but their function remains unknown.

The œsophagus is simple in structure, and the gastric skeleton, though very similar to that of *Gammarus*, is more simple; an inferior prolongation, apparently homologous with the *appendix campaniformis* described by Sars in *Gammarus* and *Mysis*, is present; the structures taken by Goodsir, on account of their long cylindrical form, to be ovaries, are shown to be hepatic tubes; they contain a yellowish-brown oily fluid. The elongated tubular heart, which lies above the intestine, is connected with the integument by bands of connective tissue; it opens to the vascular system by five clefts; a large part of the vascular system is lacunar, and the yellowish blood-corpuscles are, though not strikingly, spindle-shaped. So far as the author has been able to make them out there is but one, and not as in the allied forms described by Dohrn, two pairs of testes; in *Caprella æquilibra* each consists of a tube, which commences in a rounded process at the hinder end of the fifth segment, and rapidly becomes excessively narrow; the external appendages of the male consist of two small curved structures, which are placed on the ventral surface of the abdomen. The ovaries are likewise tubular, and are elongated structures, which extend as far forward as the second, and open in the fifth segment. The ovum, as found in the brood-pouch, is ellipse-shaped, and is completely filled with dark granules and fat-drops; cleavage seems to be complete; the larger rounded cells of the yolk appear to form the head and its appendages, with the anterior thoracic segments, while the smaller elongated parts form the hinder segments and the abdomen. The young form is exactly similar to the adult, but as a rule it remains in the pouch until its muscles are well developed, although it is quite capable, if compelled, of taking to the water.

Caprellidæ of the Mediterranean.*—Dr. Haller describes sixteen species, belonging to the genera Rota, Protella, Caprella, and Podalirius; of these, eight appear to be new. He observes that the species of the genus Caprella may be divided into two groups, in one of which the inferior pair of antennæ are provided with simple sensory hairs, while in the other the same structures are closely beset with more complicated setæ. In *C. antennata*, n. sp., of which only a female was found, the anterior pair of antennæ are nearly as long as the body.

* 'Zool. Anzeiger,' ii. (1879) p. 230.

Organization of the Phronimida.*—After some remarks on the systematic position and the more important characters of this somewhat abnormal group of the *Amphipoda*, together with a diagnosis of the new genera *Phronimopsis* and *Paraphronima*, Professor Claus enters into the discussion of the structure and organization of the group:—

Appendages.—The antennæ are particularly interesting, inasmuch as it is ordinarily stated that *Phronima* is provided with only one pair. Starting, as an examination of the earlier stages allows us to do, with the simple appendage of two joints, we find, in a very early stage of development, that the cylindrical antenna contains in its terminal joint an aggregation of cells, which become differentiated into a small ganglion, and that a seta and an olfactory filament appear at its tip; later on there appears a second filament, and, as the terminal joint increases in length, there appear a third and fourth; next we see that in the young female of *Phronima* the terminal joint increases considerably, and there appear, in pairs, a number of new olfactory filaments, while in many other Hyperida there are differentiated one or two short intermediate joints and a terminal rudimentary flagellum. In the young male the terminal joint becomes much thicker, and the olfactory filaments lose their terminal position; two joints become intercalated, and the terminal piece commences to form an appended flagellum; in the adult of all the male Phronimida there is a many-jointed long flagellum, the anterior surface of which is provided with a thick tuft of long hair-like olfactory filaments.

The second antenna is not altogether absent in the female, inasmuch as its basal joint is always present, although indeed it is so closely fused with the integument as merely to form an elevation provided with a feebly developed seta, or a more strongly developed spine. The antennary character of the elevation is spoken to by the presence on it of the orifice of the duct of the antennary gland, which corresponds to the "green gland" of the crayfish.

The mouth organs agree generally with those found in other Hyperida; the mandibles and paragnathi form a distinct oral atrium, and groups of glands, which probably have a salivary function, are developed in the maxillæ and maxillary appendages. On the thoracic appendages the joints appeared to be reduced to the coxa, but other pieces can be made out; in the fifth pair the arrangement becomes more complicated, and an elaborate glandular system may be seen in the appendages.

Alimentary Canal.—The salivary glands already mentioned are found to be complexes of four glandular cells with long efferent ducts, which are partly placed around the œsophagus, and partly in the jaws; they secrete ferments which act on starch and albumen. The enteric canal contains no glandular cells; its muscular and complicated œsophagus leads into a stomach which is provided with two secondary pouches; there are two hepatic tubes, and the narrow intestine ends, in the sixth abdominal segment, by a short rectum. The short tubes attached to this last portion, which have been ob-

* 'Arb. Zool. Inst. Wien' (Claus), ii. (1879) art. 2.

served in the Gammaridæ, and may possibly have the same function as the Malpighian vessels of the Tracheata, have not yet been observed by Claus in any of the Hyperida; it is possible, although we have no certain proof of it, that their function is performed by the epithelium of the small intestine.

Circulatory System.—The heart extends from just behind the cephalic region to as far as the middle of the sixth thoracic segment, and is provided with three pairs of ostia; the muscular bands of the heart are formed from two lateral rows of cells, between which there is a dorsal and ventral median suture; there are two arteries which arise from an elongated fissure, and have at their base two obliquely-set ostia; they are placed in the third and fourth segments of the thoracic region, and there is, in addition, in some genera a third pair of arteries in the fifth thoracic segment; the vessels pass into the perienteric canal system of the body-cavity, and their walls are formed by a transparent membrane of connective tissue, in which are contained, just as in the aorta of the Copepoda, oval nuclei. The just mentioned perienteric canal system is thus formed: there is attached to the ventral wall of the heart a septum, formed of large cells, which extends transversely across the body-cavity; a second septum holds a similar relation to the enteron, and the body-cavity is thus divided into three hæmal canals, which are separated by connective tissue, and communicate with one another by definite orifices. These primary canals extend into the cephalic region, and are supplemented by a number of peripheral secondary canals along which the blood courses in a very regular manner; as in all Arthropoda, the fluid starts from the heart in two directions, going forwards by the cephalic aorta and gastric artery, and backwards by the aorta abdominalis and the hinder gastric vessels.

Nervous System.—Exclusive of the sub-œsophageal ganglionic mass, the ventral cord consists of five thoracic and four abdominal ganglia; the last of these is formed by the concrescence of three ganglia, which are separate in the embryo, and supplies the fourth, fifth, and sixth abdominal segments. The sub-œsophageal mass corresponds to six ganglia, or, with the ganglionic centre for the antennæ, which is placed in the commissures, to seven. The peripheral nerves do not take their origin from the "dotted substance," but from the ganglionic cells of their own ganglion, from the preceding ganglion, and from the cerebroid mass. This last contains a well-developed system of commissures, part of which extends into the large optic ganglia. Turning to the eye itself, we find that this is surrounded by an investing sheath of considerable strength, which is formed by a continuation of the outer nervous covering of the brain; the cornea is formed by a special investment of the hypodermis, while the eye continues to grow with the body, by the continuous formation of new peripheral elements; this organ is, as is well known, remarkable in the Hyperida for its division into two completely separated optic areas; in correspondence with this the optic fibres are found to be arranged in two bundles, which arise from different portions of the ganglion.

Generative Organs.—Unlike what obtains in the Gammarida, the ovaries of *Phronima* and its allies are placed very far forwards in the body; flattened in form, and pointed at either end, they are provided with a thick structureless wall, supporting a well-nucleated epithelium. The ova form a single layer. The bent terminal portion of the oviduct widens out into a seminal pouch. In the young males the sperm-producing gland, and the duct which contains the spermatophores, are not distinctly separated, but this is the case also in the adult, between which and the young the chief difference is that the seminal duct of the former is longer, and contains two mature spermatophores. The paper is illustrated by eight plates, containing seventy figures.

Glands found in the Appendages of the Phronimida.*—Paul Mayer, in dealing with these glands, of which, so far as he knows, Professor Claus has alone made mention, points out that the sixth and seventh pairs of thoracic appendages are distinguished by their form and size from those in front of them; this is due to the presence, in their basal joints, of large glandular masses, which, if present in the more anterior legs, are but feebly developed. Placed in the wall of partition formed by the membrane which separates the arterial from the venous stream of blood, the glands appear to be formed by the predominant growth of some of the cells in this region, and to form groups of three or five. As to their function, it is impossible to offer anything more than supposition; at first the author supposed that they might be phosphorescent, but further observation did not confirm this view; their relation to the blood-stream suggests that they are excretory in function; or, again, they may be poison-glands. It is pointed out that in the Hyperida these glands are better developed than in the Phronimida, but they are not so regularly arranged.

"House" of the Phronimida.†—In his next "Carcinological Study" Mayer confirms the view of Claus that *Phronima* very generally makes a home for itself in *Pyrosoma*. On November 27th, 1877, the author took a fairly well-developed female from a house, which, on account of its thin, soft walls and peculiar appendage, he can only regard as being one of the Salpidæ. On the 25th of December he took a breeding female from its *Pyrosoma* habitation, and placed it in a glass with a specimen of *Abyla pentagona;* this was shortly seized on, and in some ten minutes its velum was eaten up; in a short quarter of an hour the crustacean entered on its new home. On the morning of the 26th the polyps had disappeared (? were eaten), and the home took on the characteristic shape, with orifices at either end. On the morning of the 27th the *Phronima* was removed from the Hydroid, and placed under the same conditions with a specimen of *Salpa fusiformis;* this was in like manner attacked, and on the morning of the 28th the nucleus itself of the *Salpa* had disappeared. Some hours later the invader was removed from its new home and replaced in its

* 'Mitth. Zool. Stat. Neapel,' i. (1878) p. 40.
† Ibid., p. 46.

first habitation, which had been preserved in spirit; in a few minutes the calm crustacean was quite at ease.

Observations with *Pterotrachea* only led to negative results; as to the males, the greater number were found not to inhabit such "houses," and in the case of *Phronimella*, no male was observed in one; while as to those of the female, not only were they excessively thin, but as chemical observation never revealed the presence in them of the cellulose, which is so characteristic of the integument of the Tunicata, it may be concluded that whatever the houses of species of this genus are formed from, they are not made at the expense of any of these animals.

Some young Stages of Penæus Caramote.*—Mayer's next note deals with some forms which he found in the central canal of *Pyrosoma elegans.* The points said by Heller to be characteristic of the species are:—(1) The deep longitudinal rostral groove; (2) The shortness of the terminal filaments of the superior antennæ; and (3) The projections on the lateral surfaces of the sixth abdominal segment. As to the third point, the projections were not visible in the young, inhabiting *Pyrosoma*, or in the smaller free-living forms. The first was only visible when the animal left its home, and in the youngest stages the antennary filaments are as long as the lamellar appendages of the inferior antennæ. In the earliest stages it is impossible to distinguish the sexes by any differences in the characters of their appendages, but in specimens 60 mm. long the internal branches of the first abdominal foot are closely applied to one another, although it is not till later that they fuse into an unpaired organ.

Hermaphroditism of the Isopoda.†—To English readers this is an especially interesting subject, as the results of Mr. Bullar of Cambridge, were, when published, traversed by Mr. Moseley, who had at the same time to deal with Captain Hutton of New Zealand, who had asserted that *Peripatus*, which, on account of his very notable discoveries, might be almost called Mr. Moseley's especial property, was likewise hermaphrodite.‡ Paul Mayer now states that the results of his predecessor (Bullar) were quite correct, and that therefore there really does exist a group of hermaphrodite parasitic Isopoda. The basis for these results are the observations which he has been able to make at Naples on *Cymothoa*, *Anilocra*, and *Nerocila*.

The free-living Isopoda are provided with three pairs of testes, which are placed one behind the other, and open to the exterior by a common vas deferens placed in the seventh thoracic segment; in addition to this there are two or (Oniscidæ) one penis. The female is provided with an elongated ovary and short oviduct, which opens on the fifth thoracic segment. Now in the adult *Cymothoa* what we find is this: the ovaries, which are attached posteriorly and anteriorly to the dorsal wall, take a longitudinal direction; the

* 'Mitth. Zool. Stat. Neapel,' i. (1878) p. 49.

† Ibid., i. (1879) p. 165.

‡ Captain Hutton has since allowed the existence of male specimens of *Peripatus* (cf. s. v. *Peripatus*, 'Zool. Record' for 1877).

oviduct is given off from it at right angles, and just behind the central portion; it opens on to the fifth pair of legs. On taking a *Cymothoa* 13 mm. long we find, in addition to the ovaries, testes, the vasa deferentia of which can be easily followed into the penes. So that the hermaphrodite arrangement seems tolerably certain; tracing the matter still further, we may observe animals when they are taken from the brood-pouch of their mother, as Bullar does not seem to have done; in such, the external genitalia are not developed, and the tissues of the internal organs are still in an altogether embryonic condition; four regions may, however, be made out, of which three go to form the testes, and one the ovary; two efferent ducts, oviduct and vas deferens, may also be made out, though they are as yet very short. In the next stage the testes were enormous as compared with the ovary, and the two penes were developed; in the succeeding stages, the male organs were observed to be in functional activity, and ova were developed in the peripheral portion of the ovary. As affecting the supposition that the "testes" observed by Mr. Bullar were "spermatophores," it is of interest to note that Mayer expressly states that he was able to make out the different stages in the development of the sperm; in the anterior portion of each vesicle there were small cells, not to be distinguished from epithelium, which were connected with a number of larger vesicular cells, and succeeded by sperm-cells, with very short tails, and then by bundles of still riper sperm, exactly similar to those found in the terminal portion of the vas deferens. Notwithstanding the presence of the tail, Mayer, no more than Bullar, was able to observe any movement of the sperm; and this is especially remarkable, inasmuch as the parasitic Cirripedia are the only members of the great group of the Crustacea in which mobile sperm-cells have as yet been observed (always excepting *Limulus*, which has so many points of affinity to the Arachnida).

From what has been said, it will be seen that the young individuals appear to be males, and the older forms females.

The view of Bullar that the ancestors of the parasitic species were diœcious is supported by the investigations of Mayer, who remarks further that in other Isopods he has observed indications of hermaphroditism, inasmuch as in some females of the genera *Cirolana* and *Conilera*, he has observed a filament passing just like a vas deferens, to the seventh segment, together with rudiments of the testes. Interesting as this observation undoubtedly is, the questions which it raises must for the present remain unexplained.

Asellus cavaticus.*—Dr. Max Weber, having had an opportunity of examining this remarkable form at Bonn, takes the occasion to point out certain characters which distinguish it from *A. aquaticus*, and which have hitherto escaped observation. In correlation, probably, with the absence of eyes, the olfactory organs are much larger in *A. cavaticus*; in the female the superior antennæ are nine-jointed, and the last three joints are each provided with an olfactory process,

* 'Zool. Anzeiger,' ii. (1879) p. 233.

while in the male the same appendages are twelve-jointed, and six of the joints have an olfactory function; in *A. aquaticus* the number of joints in the antennæ is large, but still only three are olfactory, while in the largest of the males the number of "olfactory joints" is only four. The increase in the number of these appendages in the male, which even in *A. aquaticus* has one more than the female, is due probably to sexual selection, and to the necessity of the blind male seeking the female in the dark cave. The first pair of swimming legs in the female of *A. aquaticus* are rounded, thin, and thickly covered with fine hairs, while in *A. cavaticus* they are semilunar, with a broad basis and continued to a sharp point, while the hairs are either completely absent or sparse and short. An arrangement obtains in the liver of *A. cavaticus*, which is only temporary in *A. aquaticus;* the superior pair of hepatic tubes are scarcely a quarter of the length of the inferior pair, while in the other form they gradually attain to the same length, and extend along the whole of the body; but, as if in compensation for this, the constituent hepatic cells are of a much larger size.

New Peltidia.*—Dr. G. Haller, in describing some new Peltidia, states that he preserved these small Copepods in Farrant's medium, which retained the colour and external form admirably. The new *Zausoscidia* is so called from its having the general structure of *Oniscidium* with the characters of *Zaus* in the two rami of the first pair of feet. The single species is called *Folii*. A *Porcellidium* smaller than any yet known (♀ ·55 mm., and the ♂ ·71 mm.) is described under the name of *parvulum*. Three new species of *Oniscidium* are also described briefly.

Vermes.

New Species of Tænia.†—Professor Perroncito describes a form which he has known for several years, and of which he has obtained a large number of specimens; hitherto confounded with *T. expansa* or *T. denticulata*, it is always characterized by its constantly white colour, hence the name *alba* now proposed for it. A technical description and a plate follow.

M. Moniez describes‡ *T. Giardi*, which is frequently found in the sheep, and which differs from *T. denticulata* in the position occupied by the male products, and by the arrangement of its ova; as to the development of these latter, it is pointed out that the elements of the "fundamental tissue" are not converted into a reticulum, but form a continuous band; this band takes on an undulating direction, in which it is followed by a narrow canal, into which the ova pass after fecundation; the ova gradually pass into the interior band, and it and the outer wall of the canal form a capsule for them. The receptaculum seminis gives rise to three "currents" of ova, two of which pass into the adjacent ovary, while the other passes over to the other side.

In *T. pectinata* a number of irregular and communicating clefts

* 'Zool. Anzeiger,' ii. (1879) p. 178.
† 'Arch. Naturg.,' xlv. (1879) p. 235.
‡ 'Comptes Rendus,' lxxxviii. (1879) p. 1094.

are formed in the tissues of the animal; into these the ova fall, and there undergo further development.

Notes on the Turbellaria.*—Dr. Ludwig Graff commences some observations on this subject, with a not unfounded complaint as to the confusion which he finds to obtain in the systematic zoology of this group, of which he promises a revision; he then gives some account of the urticating organs of these animals, as to which there are at present but few authentic reports; in a new *Stenostomum*, which he found at Trieste, and which he dedicates to that veteran zoologist, Siebold, he found urticating capsules, which were of interest as being developed in just the same way as the rod-shaped bodies found in the cells of the parenchyma, and so affording support to the doctrine that the rods and the urticating capsules of the Turbellaria are homologous structures; in another new form—*Stylochus tardus*—which was also found at Trieste, the rod-shaped bodies were completely absent, and the urticating capsules were in consequence very richly developed.

Drawing attention to the fact that Graff has observed *chitinous* structures, in the form of spines, in the integument of the Turbellaria, we have to note that there are interspaces between the longitudinal bands of the dermo-muscular tube, which have hitherto been regarded as being in all cases continuous, and that the observations now under notice confirm the view of the Russian naturalist, Uljanin, that some forms among the Turbellaria have no cœlom; in such forms the nutriment passes by a narrow cleft into a soft medullary substance, rich in vacuoles and fat-drops, which is very similar to what is seen in the Infusoria, with which they seem, *pro tanto*, to have closer relations than is now ordinarily supposed. In the great majority of forms, however, there are distinct walls to the enteric tract, and the cœlom is then filled with a lacunar connective substance, the parts of which may be thick and inclined to form broad plates, or thin and feebly developed; the contained fat-drops usually include a coloured watery fluid, which has some influence on the external coloration of the animal in those cases in which there are no other pigments present; as a rule, however, there are such, which are found imbedded in the connective substance, while the epithelium itself is always colourless. The observation of Oersted, that the spermatozoa vary greatly in character, is shown to be true of the rhabdocœlous, but not of the dendrocœlous forms. Graff's further investigations will be awaited with interest.

Studies on the Nemertinea.†—Herr V. Kennel, in an elaborate paper, deals with two very interesting forms, *Malacobdella* and *Geonemertes*. Of these two, the former has long been regarded as a Leech, but Semper and Hoffmann have shown that it rather belongs to the *Nemertinea* than to the *Hirudinea*. The specimens examined by Von Kennel were found in *Cyprina islandica*, and he notes that they were never found in *Mya arenaria*; the former molluscs, at the station at which he observed—Kiel—were taken from a region which

* 'Zeitschr. wiss. Zool.,' xxx. (Suppl.).
† 'Arbeit. Zool. Zoot. Inst. Würzburg,' iv. (1878) p. 305

was often dry for a long period every day; as a rule, the larger examples were found in older, and the smaller and younger specimens in younger animals, but this was not always the case. As their name implies, the *Malacobdellidæ* have a body of extreme softness; when young they are, except in the region of the sucker, of very much the same breadth all along their whole extent. The oral aperture is placed at the anterior end, and is in the form of a transverse cleft; the pharynx is intensely white, and may be seen through the transparent integument; the intestine is much narrower than it, and is of a brownish or reddish-yellow colour; the proboscis is of an opaque white, and on either side of the pharynx there are cerebral ganglia, which are small, and white or yellowish in colour.

The form in question seems to have been known to O. F. Müller ('Zoologia Danica,' 1779), and has since been examined by De Blainville (1827), Blanchard (1845), and Van Beneden. The result of Von Kennel's inquiries is the confirmation of the Nemertine character of the form; the surface of the body is completely ciliated, the proboscis is of the typical form, the vascular and excretory organs are of just the same type as in the other Nemertinea, and the nervous and muscular systems point to the same conclusion; the anal nervous commissure has been already found in *Pelagonemertes*. When, however, we come to inquire as to the position which it should take in this group, we find it necessary to form a new family; the Nemertinea, hitherto divided into three families, contain one, the Enopla (Tremocephalida), in which the proboscis is armed with spines, the dermal musculature confined to two layers, and the nervous system inferior to it; and two, Rhocmocephalida and Gymnocephalida, in which there are three dermal muscular layers; between the two innermost lies the nervous system; and in these—*Anopla*—the proboscis has no armature of spines: the fourth, and new family, may be thus defined:—

Malacobdellidæ.—No armature of spines to the proboscis, the dermo-muscular layer arranged in an external, circular, or an internal, longitudinal layer; no cephalic grooves or lateral organs; enteric canal simple, and forming several coils; nerve-trunks free from the muscular system, and united posteriorly by an anal commissure; a broad sucker at the hinder end.

Genus: *Malacobdella.* Characters of the family.

Species: *M. grossa* O. F. M. Body flat and broad, mouth anterior, pharynx broad; transparent and white (male), or yellowish—grey-green posteriorly—(female). Semi-parasitic in the mantle-cavity of various Lamellibranchs.

Geonemertes palænsis, Semper.—This interesting terrestrial Nemertine, which was found by Professor Semper in the Pelew Islands, has as yet been very incompletely observed. This animal, which is from four to five centimetres long, is rounded and somewhat truncated anteriorly, and of a reddish colour; the head is provided with two groups of eye-spots, of which there are three eyes in each, one larger than the other two. The mouth is placed at the most anterior end of the body; the anus is dorsal, and the enteric tract is, as in most

Nemertines, provided with a number of lateral diverticula. The body is invested by a well-ciliated simple epithelium, in which there are dark pigment granules, but the rod-like structures, so commonly found in the integument of allied forms, are here completely absent. The dermo-muscular tube is formed of an external circular, and an internal longitudinal layer; the whole of the cœlom is filled with connective tissue. The testes and ovaries are found, as they are in some other rare cases among the Nemertinea, in the same individual. The proboscis has exactly the same structure as in the other Enopla, but, as in Malacobdella, it opens *into* the pharyngeal cavity, and not in front of it or above it, as in most of these forms. The nervous system is of the ordinary and typical form.

All the points already regarded point to the general similarity of *Geonemertes* with the rest of the Nemertinea, but there remains to be noted a special organ of very curious character. At the anterior end of the body, and dorsally to the oral aperture, there is a fine pore, which leads by a short canal into a cavity which has its long axis set transversely to the longitudinal axis of the body; the canal and the cavity are lined by a simple epithelium, which passes without any distinct demarcation into the investing cell-layer of the body; the cilia in the hinder portion of the enlargement being only larger than in the anterior portion, and in the canal. Connected with it there is another cæcal sac, which is elongated in form and circular in transverse section; its only contents was a fine coagulum. This organ has apparently some connection with the terrestrial habit of the animal, but whether it is or is not sensory in function is still an open question.

The circulatory organs are of the ordinary Nemertine type, and excretory pores still require to be observed; they would be best seen in fresh specimens.

Histology of Convoluta Schulzii.* — This green Rhabdocœle Planarian was the subject of the observations on chlorophyll in the green Planaria by Mr. P. Geddes, referred to at p. 161 (from 'Comptes Rendus'), which now appears in the 'Proceedings of the Royal Society' with additional remarks on the histology of the animal, the general characters of which have been already given by Schmidt.

Mr. Geddes first notices an interesting point in the histology of the ciliated ectoderm. In teased preparations, kept cold, the ciliated cells often become amœboid, some of the cilia changing into slender finger-like or stout fusiform pseudopodia. These often retain their curvature parallel to the unaltered cilia, and he has even seen the finer pseudopodia contracting gently in time with the cilia of the same cell, thus establishing a complete gradation between the rhythmically contractile cilium and the amœboid pseudopodium through what is really a rhythmically contractile pseudopodium. Haeckel and others have accumulated many instances of the transformation of ciliary movement into amœboid and *vice versâ*, but only by Professor Lankester † has the passage-form, the cilium-like pseudopodium, been actually observed.

* 'Proc. Roy. Soc.,' xxviii. (1879) p. 449.

† 'Quart. Journ. Micr. Sci.' (1870), p. 292.

It is important that Lankester's passage-form occurred during the transformation of amœboid movement into ciliary, while the author finds it exactly the same thing during the reverse change.

Two distinct kinds of organ exist in *Convoluta* and other Rhabdocœles, and have been confused under the same name. First, the heap of coloured rod-shaped bodies, the original "Stäbchen" of Max Schultze,* which furnish in *Convoluta* when treated in alcohol a yellow solution; and, secondly, large and long spindle-shaped bodies, generally arranged singly, each containing a sharp brittle needle, of which the point lies close under the apex of the spindle. In a teased preparation they are generally empty, showing the tube in which the arrow lay, and with a little granular protoplasm hanging round the mouth like the smoke of the explosion. The dart is generally propelled for some little distance, but sometimes sticks in the mouth of the tube. Graff's view that these are offensive weapons is certainly the right one, but they are constructed on so distinct a plan from those of Cœlenterates that they might better be called sagittocysts than nematocysts.

Below the epidermis lie the circular and longitudinal muscles, and beneath them comes the layer of chlorophyll-containing cells. The chlorophyll is not collected into granules as in the higher plants, nor into drops as in the green cells of *Vortex viridis*, but is diffused throughout the whole protoplasm of the cell, which is thus very intensely coloured. One, or sometimes two, nuclei are present, besides an irregular heap of granules. It was very difficult to break up the cell completely, and so liberate the granules, but in one or two fortunate preparations treated with iodine the blue coloration assumed by many of these granules proved that we have here an actual deposit of starch quite like that which Sachs has shown to take place within the chlorophyll granules of the plant.

Deeper than the green layer lie colourless granular nucleated cells, which may be spherical or branched. These yield with iodine the red-brown reaction of glycogen very conspicuously indeed. All the internal tissues are bathed in that abundant slimy protoplasm so often adduced in evidence of the infusorian affinities of the lower Turbellaria, which may well serve instead of a special circulatory fluid as well as for digestion, any distinct alimentary canal being absent.

The development of the generative products is of interest. An apparently ordinary mesoderm cell enlarges and divides into an oval mass of about twelve to sixteen segments. The granular protoplasm of these is gradually drawn out into the very long spermatozoa, and thus each testicular mass is transformed bodily into a bundle of neatly-folded spermatic filaments. The ova are also developed by the division of a mesoderm cell. There are no separate vitellaria, but the yolk of granules seems to arise in the finely granular amœboid protoplasm of the developing ovum.

Everywhere imbedded in the mesoderm are numerous small colourless cells scarcely so big as a frog's red blood-corpuscle. These are more or less pear-shaped, with a large central cavity; and lining one

* 'Zeitschr. wiss. Zool.,' xxv. p. 421.

side of the interior of this cavity, and parallel to the long axis of the cell, are a number of distinct transparent homogeneous filaments inserted above and below into the ordinary granular protoplasm which constitutes the remainder of the cell. In a teased preparation some of these cells are easily found in a state of rapid rhythmical contraction, giving as many as 100 to 180 energetic beats per minute. The form of the cell alters with every pulsation, shortening and broadening like a contracting muscle. This change of form is simply impressed upon the cell-body by the contraction of the internal fibres, and does not therefore truly correspond to that observed in a muscle. Some cells also of extreme curvature (for hardly any two are quite alike) bend sharply and return with a spring. The movements soon become slow and incoordinate, and waves can be seen passing along the separate fibres independently of each other. The movement stops altogether, and the cell bursts, but the fibres resist for some time longer the destructive action of the water.

Mr. Geddes was never able to observe any rhythmical contraction, but at most a feeble quivering within the cell while in the body of the animal, nor to make out any trace of definite arrangement. Max Schultze has described how the alimentary canal of the higher Planarians swarms with *Opalinæ*, and it is possible that these so singular structures may be excessively modified parasitic Infusoria. In any case, the main histological interest lies in the fact that these pulsatile cells cannot be classified either with ciliary or amœboid, with plain or striated muscular cells, but present a distinct type of contractile structure.

Planaria Limuli.*—Dr. Graff points out that the Planarian parasitic on Limulus (the American king-crab), and so well entertained as to be present in large numbers ("more than one hundred") on it, is not the same as *Planaria angulata*. Somewhat similar in appearance to *P. lactæa*, it differs from it by its pointed anterior end, and by the possession of a large posterior sucker. The bilobed cerebral mass has an eye, on either side, supported by a pyriform swelling; the eye is covered by black pigment, and the lens is expressly stated (in opposition to Minot) to be made up of a number of cells, as it is in all fresh-water Planarians and in all Rhabdocœla which Dr. Graff has examined. The longitudinal nerve-trunks are well developed in this new species, and are united at the posterior end, above the sucker, *without any diminution* in size; from their point of union delicate nerve-branches are given off to the sucker; the longitudinal trunks give off lateral branches at regular intervals, and, corresponding to these, there are transverse anastomoses, so that a complicated meshwork of nerves is to be observed in these creatures. Development is effected without any metamorphosis, and within the cocoon; in embryos ½ mm. long the enteric tract is not differentiated, and the cerebrum has the form of two transversely-set, oval masses of cells. The eyes first appear when the embryo is 1 mm. long. Each cocoon contains from two to nine embryos, and forms a yellowish-brown oval capsule, about 3 mm. long and 1½ mm. broad, while it has a

* 'Zool. Anzeiger,' ii. (1879) p. 202.

stalk of about ½ mm. in length, and is attached to the gill-lamella of the abdominal appendages of the king-crab.

Classification of the Monogenetic Trematoda.*—It is to Dujardin that zoology owes the first classification of the Trematoda, which name was first used by Rudolphi (1808–1810). The French naturalist recognized three families, and his work has been subjected to changes at the hands of his successors; it was not, however, till 1861 that a really natural classification of these forms was put forth by M. P. van Beneden, who recognizing and giving the proper weight to the striking differences to be observed in their modes of generation, divided the Trematoda into the Monogenea and Digenea. In addition to the five families formed by Van Beneden and Hesse, Dr. Taschenberg now proposes two new ones, Monocotylidæ and Microcotylidæ; and divides the Monogenea into two families of Tristomeæ and Polystomeæ, which differ in the following points: in the former the anterior end of the body is not narrowed, there is no terminal sucker, and the ova are only provided with a filamentous appendage at one pole, while in the latter there is a large posterior sucking disk, the body is elongated and narrower anteriorly, while the ova frequently have two filamentous appendages.

Entoparasitic Marine Trematodes.†—An account of the morphology of several species is given by A. Villot.

The author recommends hardening the specimens in absolute alcohol, imbedding in glycerine soap, staining the sections with picrocarmine or hæmatoxylin, clarifying with oil of cloves or creosote, and mounting in balsam.

He describes three species of *Distomum*, one of *Monostomum*, one of *Holostomum*, and six of *Cercaria*, for the details of structure of which we must refer to the paper itself, confining ourselves to the point of chief morphological interest, namely, the account of the vascular system as observed in *Distomum insigne*, a large species, found in the digestive canal of the elasmobranch *Echinorhinus spinosus*.

The vascular system in this species consists firstly of a Y-shaped contractile vessel, opening posteriorly by a terminal pore, and secondly, of a capillary network, permeating the tissues and anastomosing at intervals, forming true sinuses. These dilatations are especially abundant just beneath the integuments in the outer layer of parenchyma, where they form a distinct layer, presenting the appearance in cross section of a multitude of cells, for which, indeed, they have often been mistaken.

Villot considers that this apparatus is both excretory and circulatory in function, the office of excretion being assigned to the contractile vessel, while the extensive system of capillaries and sinuses serves for the transport of nutrient matter from the alimentary canal to the various parts of the system; and he remarks that we have here "a fresh example of the tendency to the *accumulation of functions*, which always accompanies the degradation of the organism," and

* 'Zeitschr. ges. Naturw.,' lii. (1879) p. 232.
† 'Ann. Sci. Nat. (Zool.),' viii. (1879), Nos. (2–3).

which is, of course, the precise converse of the principle of division of labour.

Helminthological Studies.*—It is quite impossible to do more than draw attention to the energy of Professor von Linstow, from whom a further contribution of "Helminthological Studies" appears in the 2nd part of the 'Archiv für Naturgeschichte' for 1879. Of forty-two forms described, and mostly figured, nineteen are regarded as new. A useful table is given of the characters of the eight species of the genus *Distomum*, which are known to be found in German reptiles, in the course of the description of a ninth species (from *Anguis fragilis*).

Ascaris parasitic in the Lion.†—M. Chatin describes immature, male, and female forms of this worm, and shows that in the absence of the membranous expansions ("winged at its head") and in the characters of its mouth it differs from *A. mystax* which inhabits the domestic cat; in addition to this there are differences in the digestive tube and generative organs which speak to *A. leptodera*, as defined by Rudolphi, being a distinct species.

Ascaris of the Orang-Outang.‡—The same author enters into the details of the structure of this parasite, which has ordinarily been regarded as *A. lumbricoides;* the new species *A. satyri* differs, however, in its smaller size, while the body is more closely striated, the "buccal valves" (or labial lobes) are much smaller, the œsophagus is provided with a well-marked enlargement, the uterus is more highly developed, and the ova are smaller than in the ordinary parasite of the human subject.

Filaria Otariæ.§—M. Chatin describes this new species of Nematoid parasite from the muscles of *Otaria Stelleri*, of which his bibliographical researches have revealed no previous indication. A short technical description is given.

Muscle-cells of the Nematoids.‖—In a new genus, not yet named, parasitic in *Callichthys*, M. Chatin has observed some "true" muscle-cells, which were short and ovoid, and narrower in their terminal region; easily separated by potash, they were seen to consist of a mass of protoplasm with a refractive and excentrically placed nucleus; no distinct envelope could be observed, and the cortical layer was merely differentiated.

Further Studies on the Oligochæta.¶—Dr. Franz Vejdovsky, in describing a new species—*bohemica*—of the genus *Anachæta*, points out that in it he has observed that what D'Ukedem called the "capsulogenous," and he has called the "dissepimental glands," open by two glandular efferent ducts into the pharynx, and that their secretion appears to have some function in the ingestion of nutriment, so that the *Enchytræidæ*, like most of the *Arthropoda*, possess two pairs of

* 'Arch. Naturg.,' xlv. (1879) p. 165.
† 'CR. Soc. Biol.' for 1877 (1879) p. 266.
‡ Ibid., p. 384. § Ibid., p. 204. ‖ Ibid., p. 278.
¶ 'Zool. Anzeiger,' ii. (1879) p. 183.

secreting glands, of which one (septal glands) open into the protrusible pharynx, and the other (salivary glands) at the base of this organ and into the œsophagus.

The pharynx of these worms forms a protrusible prehensile apparatus provided with a complex system of muscles; the buccal lobes in connection with it appear to be *gustatory organs*.

In describing their "lateral line" or "lateral cords," the author points out that in the terminal segment there are a number of unipolar or multipolar cells, which extend along the sides of the body between the glands of the setæ and the ventral cord, giving off, in their course, lateral branches to the setal glands, the dissepiments, and the generative organs; the greatest number of ramifications is to be found in the genital and cephalic segments. The author comes to the conclusion that these cords are to be regarded as true sympathetic nerves, and he would apply the name of "N. vagus" to the branches which are given off from the œsophageal commissures.

The "jaws" found in the buccal cavity of *Branchiobdella* are regarded as the homologues of the gustatory organs of *Anachæta*, while the "follicular" structure of the nervous system of the former may be made out also in the latter. The anatomical characters of *Branchiobdella* lead the author to form for it a special family of the *Oligochæta*, under the name of *Discodrilida*, most nearly allied to the *Chætogastrida*.

Spermatophores of the Earth-worm.*—Dr. Paul Fraisse makes some observations on the small conical appendages which at the period of reproduction are to be noticed on the neural aspect of most of the Lumbricina; called "penes," or "appendiculæ generatrices," by the earliest observers, they were regarded (in 1849) by Fritz Müller as spermatophores; but this view has been either neglected or, as by Hering, expressly rejected.

In *Lumbricus agricola* Fraisse describes these bodies as forming flattened and somewhat spirally-coiled structures, from 1 to 2 mm. in length, and from 0·5 to 0·7 mm. in breadth; at their "anterior" end, in a small cavity, there was found a drop of sperm; the cavity was so arranged as to allow the contents easily to pass out on pressure; and the bodies, which were ordinarily arranged in pairs, were attached to the twenty-third to twenty-seventh segments of the worm. It is unnecessary for us to follow the author through his descriptions of similar structures in *L. communis*, *L. riparius*, or *L. olidus*: in all cases they were, just after copulation, found to be soft, and they only gradually hardened when exposed to the air; they are always attached to the cuticle in the neighbourhood of the generative organs, and it is not difficult to get them off. *They were not found before copulation*; the spermatozoa, when expressed, exhibited lively movements.

The question now arises, where are these spermatophores developed? Great difficulties stand in the way of framing an answer; not only are the generative organs greatly complicated, but

* Semper's 'Arbeiten,' v. (1879) p. 38.

in copulation the worms become covered with a thick opaque mucous layer, which very effectually prevents observation; an examination of the efferent ducts and seminal vesicles did not reveal the presence in them of anything like the spermatophores, which, it may be observed, are attached to ridge-like projections somewhere between the twenty-fourth and twenty-ninth rings; the ridges were found to be connected with internal follicles, which were apparently setigerous, and about three times as large as the other setigerous follicles of the neural aspect of the worm. The setæ in question differed from the rest, not only by their greater size, but by the fact that they did not project beyond the surface. They are surrounded by a capsule of connective tissue, in the walls of which there are, in addition to the matrix of the setæ, some small glandular structures, very similar to those found in the "capsulogenous glands." Varying somewhat in number, these glandular tubes always lie between the hypodermis and the circular layer of muscles; they have not a wide lumen, and are generally found to be filled with a firm coagulated secretion; a branch from this follicle passes into the sheath of the seta, where it ceases to be glandular, and the epithelial cells become flattened; the spermatophores are generally found between the orifices of the two glands, and sometimes project into their ducts; before copulation the spermatophoral tubes are soft, and contain no semen; and finally, if they are found on the twenty-sixth ring (in *L. agricola*) they would in copulation be exactly opposite the male orifice of the other worm.

The paper, which is illustrated by one plate, concludes with a detailed list of the observations which were made.

Body-cavity of the Sedentary Annelids and their Segmental Organs.*—M. Cosmovici communicates the following to 'Comptes Rendus':—

The general body-cavity of the sedentary Annelids is divided into several compartments by diaphragms, which sometimes exist only in a portion of the cephalothoracic region (*Arenicolæ*, *Terebellæ*, *Clymeniæ*), sometimes throughout the length of the body (Serpulidæ); and then each segment has a cavity more or less independent of its neighbours. There are also divisions in the opposite direction. In sections there are seen a central cavity filled by the digestive tube, and two lateral ones separated from the former by muscular bands in the form of oblique diaphragms. A communication exists between all the cavities through the interstices of the fibres of the partitions. The lateral cavities contain the feet with their retractor muscles and the segmental organs; these are the *pedal cavities*.

In *Chætopterus pergamentaceus* the arrangement of the cavities in the three vesicular segments is interesting. The median cavity, containing the digestive tube and the genital glands, does not communicate with the lateral cavities, which are occupied by the renosegmental organs, except by the segmental pavilion which opens in the wall of separation.

* 'Comptes Rendus,' lxxxviii. (1879) p. 1092; 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 94.

In the *Clymeniæ* the *corpora Bojani* are very long; and at their anterior extremity the segmental organs are attached. After the eleventh segment there are no longer any renal bodies, and in their place there is a plexus of blood-vessels of remarkable abundance. The position of these networks is such that we may say that they represent *so many* corpora Bojani *formed solely by their vascular framework.*

The ovum of these animals is remarkable for the separation into two parts of the vitelline mass; one of these, the larger one, is formed of large granules, the other of very small ones. In the latter is situated the germinal vesicle and the spot, which becomes strongly coloured by picro-carminate.

Pectinaria belgica exhibits first a pair of very large *corpora Bojani*, and then two pairs furnished with segmental organs. The genital gland is on the median line, on each side of the supranervous vessel. The animal is as transparent as glass; and notwithstanding this the segmental organs cannot be perceived. It is curious that in less transparent animals these organs have nevertheless been observed by translucence and figured.

With regard to the segmental organs in the errant Annelides, we find a pair of them in each segment, with a contorted tube having an internal pavilion and an opening outwards. In the Serpulidæ (a family very rich in genera), among the sedentary forms, the same thing is met with. Lastly, in all the other Sedentaria we find the segmental organs sometimes free, sometimes annexed to the *corpora Bojani*, and in the majority of cases we may say that the segmental organs are independent of those bodies.

Hitherto we have been acquainted with three species of *hermaphrodite Spirorbis;* a fourth must be added, namely, *Spirorbis communis*, which abounds at Roscoff.

In the group Gephyrea, in *Phascolosoma vulgare*, we find on the anterior part of the two long blackish sacs, a tube furnished with a pavilion with two broad ciliated lips. The structure of the sacs shows them to be renal bodies, to which the segmental organs are annexed. The genital gland, male or female, is situate at the base of the posterior pair of the retractor muscles of the proboscis. The racemose gland is attached to an elastic thread, which is probably a blood-vessel. The ovum is remarkable for the presence of cilia at the surface of the vitelline membrane, which, when observed in front, appears finely striated.

In the subintestinal blood-vessel, in the midst of the elliptical blood-globules, we find encysted trematodes, which are carried along even into the papillæ of the proboscis, by the cilia with which the vessel is furnished. The above-mentioned papillæ appear to play a great part in respiration; in fact the whole circlet is in communication with the circulatory apparatus. The globules ascend along the walls, and descend by the centre of the papilla. Processes of the wall in the interior of the papillary cavity cause the globules to remain a certain time in contact with the delicate wall of these organs, and thus facilitate an exchange of gases. This may explain

why the animal, when quiet in a trough filled with sea water, exerts its proboscis every moment.

Segmental Organs of the Capitellidæ.*—Dr. Hugo Eisig had intended to make a general revision of the segmental organs of the Annelides, but various circumstances, and, more especially, the conviction that his object would be best attained by making a careful examination of these organs in a particular group, have led to the publication of the present essay, which is of interest and of value as bearing on those structures, which the labours of Professor Semper and of Mr. Balfour have led them to regard as homologous in the Annelides and in the Vertebrata.

In describing the organs of *Notomastus lineatus*, the author says that they are typically formed of two processes, of which the longer and broader one leads to the internal, and the shorter and more delicate to the external orifice; the two orifices are connected by a canal, the cilia of which work outwards; the internal orifice does not, as in most Annelids, float freely in the cœlom, but is closely applied to the peritoneal membrane, and is difficult to perceive; the outer one is, on the contrary, very evident, as it is placed on an elevated infundibular process. The segmental organs are also remarkable for being confined to one segment, where they lie in the groove which separates the dorsal from the longitudinal muscles; the long axis is ordinarily set parallel to the long axis of the body, and the external orifice is anterior, the looped portion posterior, and the internal orifice median in position. In the adult these organs are confined to the hinder setigerous portion of the body —to the abdomen; in the younger forms they are found, more or less distinctly, in a number of the more anterior segments, and are arranged in regular pairs, whereas in the adult they may be absent from one or the other side of a segment, or from both sides; what is more remarkable is that occasionally more than one pair of organs is to be found in one segment; but this is still more strikingly seen in *Capitella capitata*, where the "segmental organs" are confined to the anterior portion of the abdomen; in the adults examined they were found in the tenth to the twentieth or twenty-third segments of the body, and *each of these segments contained several pairs of segmental organs;* two to three in the more anterior, four to five in the median, and five to six in the most posterior segments; the organs are here firmly attached to the peritoneal membrane, with the exception of their internal orifices, and so close is this connection that in section the organs appear to be mere thickenings of the membrane; as to the internal orifices, the number is not always limited to one for each organ. The external orifices are not so easy to find as in *Notomastus*, inasmuch as they do not open to the exterior, but pass their secretion into the space between the cuticle and the integument proper; this observation was best confirmed by feeding the annelid with carmine. As a rule, the organs of each segment are distinct from one another,

* 'Mitth. Zool. Stat. Neapel,' i. (1878) p. 93.

but in some cases these were connected by a branch, the cilia of which work from the more anterior to the more posteriorly set organ. In the larval and young *Capitella* the segmental organs extend further forward, but do not extend so far back in the body. The larval organs are strictly segmental, or in other words, there is never more than one pair in each segment, and, as in most Annelids, each organ is placed in two segments, and their connection with the peritoneum is not so intimate as in *Notomastus;* the author was not able to observe any definite external orifice. As the permanent segmental organs appear the larval ones undergo degeneration.

It is impossible to avoid seeing the great importance of these observations, as bearing on the fact that, in the Urodela, Max Fürbringer has observed, and has insisted on the observation, that the "segmental organs" are not metameric, but "dysmetameric"; that observation is, as we now see, just as true of adult *Capitella* as of *Salamandra.* Let us note some other points of resemblance.

The Vertebrata were regarded as distinguished by having the segmental organs connected; this is occasionally true of *Capitella;* in some Vertebrates (Selachii, Acipenser) the primary archinephric cord remains connected with the peritoneum—just as in *Capitella,* while in others (Amphibia, Amniota) the cord becomes separated from the peritoneum as in *Notomastus.* The more anterior of the segmental organs of the Vertebrata have a tendency to become aborted; this, too, is true of the Capitellidæ. The larval Cœciliæ have one segmental organ in each segment, while the adult has a number; in *Salamandra* the organs increase in each myocomma as we proceed backwards; all this is true of *Capitella.*

The author concludes with a few words on the *receptacula seminis;* the pores observed by Claparède lead into tubes, placed between the seventh and eighth segments, which seem to have the further function of a penis or of a vulva, according to the sex.

Lateral and other Goblet-shaped Organs of the Capitellidæ.*—In continuation of his researches into the anatomy of these Annelids, Dr. Eisig now deals with the somewhat difficult matter of their sensory organs. The observations of Keferstein and Claparède had led to the knowledge of certain protuberances in the abdominal region, which were said to be provided with narrow orifices (lateral organs of the abdomen), and of thoracic pores (lateral organs of the thorax). The former, which are set along the whole of the abdomen and on each segment between the neuropodia and the notopodia, are provided with stiff hairs, sensory in function, but they are not provided with pores and do not provide for the cœlom of the animal any means of communication with the outer world; or, in other words, they are not, as Claparède thought, the external orifices of the segmental organs. Dealing with the structure of the sensory hairs, Dr. Eisig points out that there are several hundreds of them on each protuberance, from ·04 to ·06 mm. long. They are about ·001 mm. broad at their base and become infinitesimally small at their tip;

* 'Mitth. Zool. Stat. Neapel,' i. (1879) p. 278.

immovable and stiff, they appear to consist of a pale homogeneous substance. Having pointed out in detail the structure of the hairs and of the protuberances upon which they rest, Dr. Eisig comes to the conclusion that they are undoubtedly sensory organs: but how are they innervated? the sensory hairs are connected with rods, the rods with spindle-shaped bodies, and these with granular ones; between these last and the ganglionic cells of the central cord there are many points of resemblance, although the granules are without a neurilemma and without those unipolar peripheral cells which are found in the cord. As to the nerve, it is curious to observe that there passes into the protuberance a band of matter which, at first sight, is easily taken for the innervator, but which is really a muscle, for which we can easily find a function when we note that the sensory hairs are capable of being protruded and retracted. The true nerves arise from the ventral cord; three, or rarely four, being given off to either side from the ganglia; passing through the musculature of the trunk they ramify in the integument, or, reaching as far as the gill, divide into two strong branches, of which one goes to the gill and one towards the sensory protuberance; the observations, however, of our author do not allow him to speak definitely as to the innervation of the protuberances.

The remark just made will be found to apply also to the nerves of the lateral organs of the thorax; as to the pores of these organs, which are elliptical or rounded, and quite evident, no passage could be discovered by which they were connected with the perivisceral cavity of the animal; carefully examining them, Dr. Eisig one day saw a rounded protuberance project from one of the clefts; this was provided with stiff hairs altogether similar to those already observed in the abdominal region. The whole matter was henceforward clear; here as in the abdomen there were sensory organs, but here they were ordinarily hidden in cavities formed for their reception; the protective apparatus was carried a step further in the thorax than in the abdomen. The rounded protuberances are of the same form, though somewhat smaller, and the sensory hairs are exactly similar.

Leaving these, which are truly segmental organs, we deal with the goblet-shaped organs, which are irregularly scattered over the cephalic lobes, the thorax, and the proboscis; those on the first-named structure are set around its whole circumference, and in great numbers; rounded or conical in form, they are only of about one-tenth the size of the organs already described as existing on the proboscis; the sensory hairs are not so numerous and do not diminish in size towards their free end, as do those already noted, which are also about ten times as long; no observations could be made as to their structure or as to the supply of nerves to them. The goblet-shaped organs of the thorax, which are very difficult to make out, are placed in greatest number around the mouth; very similar to those of the cephalic lobes, they appear to be innervated from the ventral cord as well as from the œsophageal ring. Similar organs are found in some hundreds on the proboscis.

Bearing in mind the metameric arrangement of the lateral organs

of the Capitellidæ, we are now led to ask what is their relation to the organs of the same name among the Vertebrata? Discussing in detail the opinions of those who have busied themselves with the morphology and embryology of the lower Vertebrata, Eisig finds that the abdominal protuberances of *Notomastus* are comparable to what is found permanently in Gobius and others, and temporarily in the larvæ of other Vertebrata, while the hyaline tubes of the latter group are in Notomastus replaced by the defended position of the organs; so, too, the thoracic organs of the worm correspond to the canals covered in by integument in the Vertebrates. The author is of opinion that the "lateral lines of the *Naiades*" are not, as Semper thinks, homologous with the system of lateral organs in the Vertebrata. Turning to the goblet-shaped organs, Eisig points out that in the Capitellidæ and in the Teleostei there are goblet-shaped organs on the head, in the buccal cavity, and on the trunk of both; that in both cases they have no relation in their arrangement to the segmentation of the body, and that they are more richly supplied to the buccal cavity and lips than to the trunk, while their structure is exceedingly similar in both cases. Comparing the goblet-shaped organs with the lateral organs we observe the following points of difference:—

(1) The former are not, and the latter are, segmental in arrangement.

(2) The latter are chiefly confined to the trunk, and are found only in animals of aquatic habitat.

(3) The sensory cells of the (Vertebrate) lateral organs are short and pyriform, of the goblet-shaped organs long and filamentous.

(4) The lateral organs have long hairs, seemingly auditory, and appear to be adapted to a mechanical mode of perception, while the goblet-shaped organs have short hairs, seemingly olfactory, and appear to be adapted to chemical changes.

There are, however, strikingly similar arrangements in both; they are both epidermal structures, both form rounded solid protuberances protected by the surrounding epidermal tissue, and both contain centrally a bundle of special "sensory cells." The author appears to incline to the view that the two sets of organs have arisen independently of one another from the epidermis.

We come now to the interesting question of the function of these organs. It has been suggested by Leydig that the system of lateral organs in the Vertebrata forms an apparatus specially adapted to an aquatic habitat, and an organ of a "sixth sense"; F. E. Schultze inclines to a somewhat similar view, regarding the organs in question as being sensitive to movements in mass of the water, or of solid bodies in the water; Eisig, however, would look upon the arrangements in the way of protection and so on, which are found in the Capitellidæ, as being means for preventing the contact of solid bodies with the sensory organs.

As to the goblet-shaped organs, there seems to be but little difficulty in regarding them as having a gustatory function; strange as it may seem to us that these organs should not be distinctly limited to the buccal cavity, it may be pointed out that Schultze regards the similar

organs of the Teleostei as having a similar function, while there appears to be a general consensus of opinion that the similarly shaped (goblet-shaped) organs, which are found again on the tongue of the Mammalia, are entrusted with the duty of tasting organs.

Echinodermata.

Anatomy of the Ophiurida.*—Dr. Ludwig deals in this paper chiefly with the skeleton and with the generative organs of the Brittle-stars; pointing out the extreme difficulty offered by them, he says that he has busied himself chiefly with the, in all respects, largest form known to him—*Ophiarachna incrassata* Müller and Troschel, which came to him from Cape York.

Before considering their relations to the Asterida, he deals with the leading characters of their own skeleton. In an arm, four different kinds of skeletal structures may be made out—the jointed plates, the lateral, the ventral, and the dorsal shields. The last are almost completely rectangular, are three times as broad as they are long, at the base of the arms, and they occupy nearly the whole of the dorsal side; the lateral plates carry the four rows of spines and the tentacular scales, while the ventral plates are quadrangular, and have a somewhat convex aboral edge; on their adoral edge there is a process with a depression on either side. The joints, which are formed by the fusion of two lateral pieces, are, with the exception of the first pair, intimately connected; in form they are discoid and present four surfaces; in the centre of the adoral and of the aboral surface there are protuberances and depressions by which the several joints are connected together. On the adoral side we find superiorly two lateral cavities, and, inferiorly, a median one, while superiorly there is a median protuberance, and inferiorly two lateral ones: on the aboral side the conditions are reversed. In addition to these there are other cavities which are less evident, and which go to make up four for either side of each joint. The arrangement is, on the whole, of such a kind that movement is possible in a horizontal as well as in a vertical plane. Running along the median ventral line of the arm there is a groove, at the base of which are small orifices, which lead into five canals that traverse the joints. The adoral one serves for the entrance of a nerve, and the aboral ones for a branch of the ventral water-vessel; and it is of interest to note that the arrangements of this last-named system point, in the opinion of Dr. Ludwig, to the complete homology of the joints of the Ophiurid and of the Asterid arm. This view, which was held by Meckel and by Johannes Müller, has been lately opposed by Gaudry and by Lyman; but it is impossible to enter into a detailed description of the question here, and we can only say that the lateral shields of the Ophiurida are regarded by Dr. Ludwig as being homologous with the adambulacral plates of the Asterida, while the ventral shields of the former should be regarded as subambulacral plates, which are absent in the Asterida.

As to the skeleton of the oral region, it is thought that the ambulacral covering-pieces are parts of the ambulacra, the lateral oral

* 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 348.

shields adambulacral pieces, and the second ventral shields subambulacral; and it is concluded that the whole of the oral skeleton is formed by the conversion of the first two joints of all the five rays, together with the adambulacral and subambulacral pieces which belong to these parts.

As to the generative organs, of which so little is exactly known, it is generally stated that, in the Ophiurida, the generative products are passed into the cœlom, and thence escape by the so-called genital clefts, but it is here shown that the generative products do not take this course, and that the genital clefts do not open into the cœlom. After a review of what has been stated by earlier writers, Dr. Ludwig draws attention to the description he gave when treating of the Asterida, when he showed that the genital clefts open into depressions of the body-wall, for which he proposed the name of *bursæ genitales*, while the clefts were named "bursal clefts." An examination of *Ophioglypha* shows that in it the bursa is a comparatively wide, but very thin sac, which commences at the edge of the bursal cleft, and passes dorsally into the cœlom; at its aboral end it is continued into a narrower portion which passes over the edges of the stomachal sac towards its dorsal aspect; it is a mere invagination of the integument. The genital tubes are placed on that surface of the bursa which faces the cœlom, and the large number of fifty has been counted on each bursa; in youth they are rounded, but they gradually take on a cylindrical form; internally they are invested by a spermigenous or ovigerous epithelium, and the outer lamella of their walls is provided with muscular fibres, somewhat irregularly arranged; in general structure they resemble the similar organs of the Crinoida, Asteroida, and Holothuroida. The generative pores may be seen to form a number of small orifices, surrounded by epithelium, separated by regular distances, and leading directly into the cavity of the genital tubes, which are connected with them by very short efferent ducts; the contents are thus passed, *not into the cœlom*, but into the bursa. Having compared the arrangements in various Ophiurids, the author points out that in them, just as in the case of the branchial vessels of the Asterida, there is reason for supposing that the bursæ serve also as respiratory organs, and suggests that they may also serve as marsupial pouches. That many Ophiurids are viviparous is certain, and the suggestion is one which would free us from numerous difficulties. The paper, which is of great value, concludes with pointing out the likenesses that subsist between these bursæ found, among extant Echinoderms, in the Ophiurida only, and the "genital tubes" or "hydrospira" of the Blastoidea.

Aspidura.*—Dr. Ludwig has some interesting remarks on Dr. Pohlig's late paper on this Triassic Ophiurid,† in which it was stated that the oral shields were divided into two equal lateral parts. Striking as this relation is, it was explained by the apparently justifiable supposition that the oral shields ("buccal plates") are primitively paired, owing to their origin from the lateral plates of the

* 'Zool. Anzeiger,' ii. (1879) p. 41. † This Journal, ii. p. 581.

skeleton of the arms. Dr. Ludwig now insists on the view which he has lately put out,* that the oral shields do not belong to the series of parts which make up the skeleton of the arms, but to the interambulacral series. Evidence as to the correctness of this view is, in Ludwig's opinion, to be found in Pohlig's own paper; thus, what Pohlig calls oral shields in *Hemiglypha*, are really lateral shields, as is shown by the statement that they resemble the lateral shields, that the oral "lateral shields" are indistinct (this, of course, is due to the true oral "lateral shields" being regarded as proper oral shields, while other small plates which are mentioned in the description are seen to be the true oral shields). A somewhat similar criticism is brought to bear on the description of the characters of *Amphiglypha*.

Comatulæ of the 'Challenger' Expedition.†—Mr. P. Herbert Carpenter, M.A. has made a preliminary report on the collection of *Comatulæ* made by the staff of the 'Challenger,' which includes specimens from 45 different localities, but few of which are deep-water stations.

Comatulæ were only obtained seven times from depths exceeding 1000 fathoms. At lesser depths, 200–1000 fathoms, they were met with at 13 stations; but by far the greatest number both of species and of individuals were dredged at depths much less than 200 fathoms, and often less than 20 fathoms, at 26 widely distant stations.

The collection contains 111 species, mostly new; but as the work of examination and description progresses, it is not unlikely that forms now considered different, may turn out to be merely local varieties of one and the same species, so that the number given above may be subject to alteration.

Of these 111 species, 59 belong to the genus *Antedon*, 48 to *Actinometra*, 1 to *Ophiocrinus*, and 3, which are peculiar in having ten rays to the calyx instead of only five, to a new genus for which is proposed the name *Promachocrinus* (πρόμαχος, "challenger").

The distribution of *Promachocrinus* is as follows:—

P. Kerguelensis (20 arms).	Balfour Bay, Kerguelen,	20–60	fathoms.
	Royal Sound, „	28	„
	Cape Maclear, „	30	„
	Heard Island	75	„
P. abyssorum (10 arms).	Station 147	1,600	„
	„ 158	1,800	„
P. Naresii (10 arms).	„ 214	500	„

Ophiocrinus was obtained at four localities at depths varying from 565 to 1070 fathoms, two in the South Pacific off South Australia and New Zealand respectively, and two in the North Pacific, one off Japan, and one just north of the Philippine Islands. All the specimens belong to one species, which is by no means so slender and graceful as Semper's Philippine species from shallower water, but has a much more massive arm skeleton.

The comparative distribution of the other *Comatulæ* is very striking. Relatively speaking, *Actinometra* is extremely limited in

* This Journal, ii. p. 580.
† 'Proc. Roy. Soc.,' xxviii. (1879) p. 383; 'Nature,' xix. (1879) p. 450.

its range, both geographical and bathymetrical. It is almost exclusively a tropical genus, its northern limit being about 30° N. lat. and its southern 40° S. lat. Isolated species are known from the Cape of Good Hope, Natal, South Australia, and Port Jackson, but its chief home is Oceania, especially the Philippines. A few *Actinometra* species are also known from the west coast of the Atlantic, as South Carolina, the West Indies, Bahia, and St. Paul's Rocks.

The bathymetrical limit of *Actinometra* is likewise very slight. Nearly all the 'Challenger' species are from depths less than 20 fathoms, while only three come from a greater depth than 100 fathoms. The individual species of *Actinometra*, like the genus itself, are very local in their distribution. Each of the forty-eight species of the 'Challenger' collection has its own locality.

With *Antedon*, however, the case is different. Not only do nearly all the deep-sea *Comatulæ* belong to this genus, but some species of it have a fairly wide range. *Ant. rosacea* ranges from the north of Scotland to the Mediterranean, while *Ant. Eschrichtii* is found over a much wider area. It is well known on the American coast, and was dredged by the 'Challenger' off Halifax, while the 'Porcupine' met with it in the "cold area" of the North Atlantic.

Some *Antedon* species occur in duplicate from different localities. Two species from near the Kermadec Islands (S. 170), also occur in the neighbourhood of the Fijis (S. 174, 175). A third species was dredged at Stations 147 and 160, two localities in the Southern Sea, in nearly the same latitude, but separated by almost 90° of longitude. A fourth species came up from 1070 and 775 fathoms, off the Admiralty Islands and Japan respectively.

The above facts would seem to show that, with few exceptions, the geographical range of the individual members of the family *Comatulidæ* is exceedingly limited, nearly every species having its own locality, and that not a very extensive one.

The voyage of the 'Challenger' has settled a curious question in connection with the Crinoids, the origin of which is due to Loven. It refers to *Hyponome Sarsii*, a so-called recent Cystid, which turns out to be nothing more than the disk of a *Comatula*, minus its skeleton. The antambulacral plating may be very extensive, forming a complete pavement over the ventral surface of the disk as in many *Pentacrini*; and the ambulacra are not wide and open as is usual in most *Comatulæ*, but almost entirely closed by the approximation of the marginal leaflets at their sides, so that the food-grooves radiating from the mouth are converted into tunnels.

The plates in the marginal leaflets are probably movable as unplated leaflets are in *Antedon rosacea*; so that they can be erected when the arms are spread out, leaving the grooves open for food particles to travel towards the mouth. On the other hand, when the arms are all contracted over the disk, the marginal plates fold over the grooves and cover them in. This is the condition of most spirit-specimens, but it is not in any way comparable to that of the Palæozoic Crinoids, in which the mouth is truly subtegminal while the ambulacra become real tunnels beneath the upper surface of the vault.

Sections through one of these plated *Hyponome*-disks show that all the various structures which underlie the grooves of ordinary *Comatulæ* are present and exhibit their usual characters.

The examination of the 'Challenger' *Comatulæ* has entirely confirmed the opinions held by Dr. Lütken and the author respecting the distinguishing characters of *Antedon* and *Actinometra*. Both agree in referring forms with a (sub) central mouth, five equal ambulacra, and no terminal comb on the oral pinnules, to *Antedon*. On the other hand, species with an eccentric mouth, a variable number of unequal ambulacra, and a terminal comb to the oral pinnules, belong to *Actinometra*.

It will be seen at once that these characters are of no use in distinguishing the genera of fossil *Comatulæ*. But there are very considerable differences in the shape of the radials and centrodorsal piece in *Antedon* and *Actinometra* respectively, and as these are exactly the parts which are most met with as fossils, the generic determination of a fossil form is almost as easy as that of a recent one, which has given up its disk to produce a *Hyponome*. The author has shown elsewhere that in *Act. polymorpha* and *Act. solaris*, half, or even more than half, of the arms may have neither ventral groove, tentacles, ambulacral epithelium, nor ambulacral nerve. No less than twenty-three out of the forty-eight species of 'Challenger' *Actinometræ* may have more or fewer of such ungrooved arms, in which the ambulacral nerve is entirely absent. These arms are usually those which come off from the hinder part of the disk, but in one gigantic Philippine species with over 100 arms there are several ungrooved arms upon each radius. Evidence of this negative character appears to the author to be a serious objection to the German view, that the ventral bands constitute the sole nervous apparatus of the Crinoids; and on the other hand, to strengthen the opinions held by Dr. Carpenter and by the author, that the axial cords of the skeleton are also nervous in character.

Cœlenterata.

New Genera and Species of Corals.*—The Rev. J. E. Tenison-Woods describes three new genera and one new species of Madreporaria corals; the genera being *Vasillum* (*tuberculatum*), *Diechoræa* (*boletiformis*), and *Phyllopora* (*spinosa*) and the new species *Balanophyllia dentata*.

In *Vasillum* (one of the Turbinolidæ) the corallum generally represents *Sphenotrochus*, but in place of a columella the septa of opposite sides of the calice unite to form separate compartments.

Diechoræa (one of the Poritidæ) is a very remarkable instance of the appearance in the present epoch of characters which belong to long-extinct forms of life united to others which are our commonest forms of zoophytic life. *Microsolena* is a fossil coral of the upper Jura of France and great oolite of England, and is distinguished by having all the individuals enclosed in a strong or compact epitheca, and the septal apparatus confluent. The zoothome thus resulting is massive,

* 'Proc. Linn. Soc. N.S.W.,' iii. (1878) p. 92.

turbinate, gibbous, digitiform, dendroid, or spread out in plates. There are about twenty fossil species known, and they appear as late as the later Mesozoic rocks. *Diechoræa* is a *Microsolena* in which the septa are not confluent. It would belong to the turbinate division, but must be placed in a genus by itself, for the septa are not only trabecular, irregular and distinct, but the gemmation is most peculiar, being intracalicular and in congeries of individuals, rising one above another. The walls are also entire above, and form more or less complete partitions above with none of that open, spongy tissue which occurs in *Alveopora*, neither are there any of those horizontal partitions across the cells, which give that genus the tabulate character of the ancient *Favosites*. From these peculiarities of the walls, septa, and mode of gemmation, the name of *Diechoræa* is given (from διέχω, to stand apart, in allusion to the non-confluent septa). The genus is thus characterized:—Poritinæ with the individuals enclosed in a common and conspicuous epitheca, like *Microsolena*, but with the septa not confluent, apart and trabecular; gemmation intracalicular.

We may suppose that the real septa upon which the animal rests are the granular points on the summit of the wall, and that the spiculæ or pseudosepta in the fossa are the supports for the base of the animal. The calices themselves are quite microscopic, three or four of them occupying no more than the space of a millimetre.

Phyllopora is one of the Seriatoporidæ. Cœnenchyma hispid, compact; tabulæ rarely visible; calices distant; septa exsert, distinct, and in cycles.

Balanophyllia dentata (Madreporidæ) was parasitic upon a Polyzoon (*Eschara*) from the south coast of Australia, and was so completely imbedded in the foliations that they had to be broken away to extract it.

The author is not aware whether any other instances are known of corals growing on tufts of Polyzoa, but as this has been found, collectors will probably make a more diligent search, as the specimen of *Eschara* had been a long time in the Macleayan Museum, and had been many times handled before the existence of the *Balanophyllia* was observed.

In other papers * six other new species of corals are described, viz.:—(from Darnley Island) *Symphyllia hemispherica*, *Mussa solida*, *M. laciniata* (from Wellington, New Zealand), *Cylicia Huttoni*, *C. vacua*, and (from north-east coast of Australia) *Placotrochus pedicellatus*.

Ctenophora of the Gulf of Naples. †—Dr. Carl Chun's arrangement of these forms is as follows:—

TENTACULATA.

With "grappling-lines."

Two long tentacles, simple or beset with lateral filaments. All the vessels end blindly. 1. *Cydippidæ*.

Tufts of grappling-lines which are set on either side of the

* 'Proc. Linn. Soc. N.S.W.,' iii. (1878), pp. 128 and 131.
† 'Mitth. Zool. Stat. Neapel,' i. (1879) p. 180.

margins of the mouth. Primary tentacles present or absent, vessels communicating. The young forms are Cydippoid.

With oral lobes. 2. *Lobatæ.*

Body band-shaped. 3. *Cestidæ.*

NUDA.

No "grappling-lines."

Vessels ramify largely. 4. *Beroïdæ.*

It will be seen that by this arrangement we get two distinct groups, or subclasses; the four suborders have been long recognized, but in addition to the presence or absence of the grappling-lines, Chun points out that, as McCrady first saw for the *Lobatæ*, both these and the *Cestidæ* have clearly diverged from the *Cydippidæ* more lately than the *Beroidæ*, inasmuch as they still retain in their life-history an indication of their parentage. Leuckart recognized two subdivisions equivalent to the Nuda and Tentaculata, which he named respectively Eurystomata and Stenostomata; it is now pointed out that the difference in the size of the mouth, or of the stomach, is not a character on which any reliance can be placed. Taking then the tentacles as his guide, Dr. Chun shows that where they have been stated to be absent in any one of the Tentaculata, it is on account of the insufficiency of the observations, or of some confusion of these with other organs. The large mouth of the Beroidæ, with their large sabre-like cilia, the great development of the musculature and the branching of the vessels, are points by which these forms make up for the absence of the "grappling-lines," which are not present even in the larval stages.

The filaments are two in number in the Cydippidæ, and are provided with a number of secondary lateral filaments; in the Cestidæ and Lobatæ they are present in greater numbers, as simple filaments, even where the larger tentacles are also present; these simple filaments are set in a groove, formed by a fold of the integument, which extends from the base of the tentacles, along the margins of the mouth, as far as the lobes.

A further point, which appears to be of value in the classification of the Ctenophora, is to be found in the arrangement of the water-vascular system, which is in all cases really arranged along two radii; the variations in the arrangement are indicated in the foregoing table.

With regard to the systematic portion of the paper, of the Cydippidæ, four species of the Pleurobrachiadæ, and four of the Mertensidæ, were found in the Gulf of Naples; of these *Pleurobrachia rhodopis*, *Euplokamus stationis*, *Lampetia pancerina*, and *Thoë paradoxa* were discovered by Chun.

The author is of opinion that the five families formed by Agassiz in the Lobatæ cannot stand, as there are not presented any characters which should be regarded as family ones; two new species are described.

With regard to the Cestidæ the author points out in a note that there is no Latin and no Greek word *cestum*, but that in both

languages we find the masculine form, so that the well-known "*Cestum Veneris*" should be "*Cestus Veneris.*"

Of the Beroidæ forty-five species and some eight genera have been described by various zoologists; this number is apparently due to the great difference in characters which may be found to obtain between forms at various stages of development, while some exhibit a great tendency towards variation, and it seems to the author that quite a third of the species have been formed on differences in pigmentation. To take an example: from the common *Beroë ovata* of the Mediterranean, *Idyia roseola* (western coast of North America), *B. cucumis* (Greenland, Norway, and Baffin's Bay), *B. capensis* and *B. punctata* (Cape of Good Hope and Azores) and *B. macrostomus* (Pacific and Indian Oceans) differ too slightly to form other species. In the Gulf of Naples Chun finds *Beroë ovata* and *B. Forskälii.* The paper is illustrated by one plate.

Protozoa.

Eozoon Canadense.—An excellent abstract of the chief points of Dr. K. Möbius's recent monograph on "The Structure of *Eozoon Canadense* compared with that of the Foraminifera," appears in 'Nature,'* copiously illustrated with nineteen woodcuts.

Dr. Carpenter also announces † that he has in preparation (in conjunction with Professor Dawson) a full and complete memoir on *Eozoon*, based upon investigations far more comprehensive (he considers) than those of Professor Möbius. It will necessarily occupy considerable time in consequence of the elaborate illustrations it will require. And in the meantime Dr. Carpenter makes some brief remarks on that part of the discussion which relates to the so-called "canal-system."

Among the numerous figures given by Möbius of *sections* of the "canal-system," there is not one which represents what Dr. Carpenter described and figured, when he last wrote on the subject,‡ as "what appears to be the typical mode of its distribution." Nor is this brought out in any of the small number of figures given of the *internal casts* obtained by decalcification, though, in fact, it is only when the sections are interpreted by such solid models, that the real forms and relations of these "canal systems" can be made out.

Having been furnished by Professor Dawson with numerous specimens obtained from different localities and in different states of mineralization, he is now able to assert with confidence that the peculiar distribution described and figured by him from the actual specimens five years ago, is the *regular and characteristic "canal system" of Eozoon.* His cabinet now contains hundreds of examples of it, both in transparent sections and in the solid models obtained by decalcification; and these last, in partially "dolomitized" specimens, show the following singular peculiarities, which do not seem to have fallen under Professor Möbius's observation. When a band of dolomite runs through the calcite layers, (1) the "canal

* 'Nature,' xx. (1879) pp. 272, 297. † Ibid., p. 328.
‡ 'Ann. and Mag. Nat. Hist.,' June 1874, pl. xix.

systems" in its neighbourhood are very commonly filled with *dolomite*, instead of with serpentine; (2) in one and the same canal-system, some of the branches are often filled with dolomite, and others with serpentine; while (3) individual branches are often partly filled with one mineral and partly with the other.

How these facts can be explained, except by the *pre-existence of a system of canals in the calcareous layers* into which these minerals have penetrated, he is unable to conceive; and that they thus afford demonstrative evidence of a structure which cannot be otherwise than *organic* is not merely his own opinion, but that of Professor Geikie, who has been for some years engaged in the microscopic study of the metamorphic rocks of Scotland, and Professor Bonney, who has been similarly studying the Cornish serpentines.

Whether, when taken in connection with the general structure of the organism, these "canal-systems" indicate its Foraminiferal affinities is, of course, an altogether different matter. To Professor Möbius the difference seems greater than the resemblance; but it is noteworthy that his comparisons are limited to types examined by himself, and do not extend to *Calcarina*, in whose "canal-system" Dr. Dawson and the writer recognize the nearest approach to that of *Eozoon*. He cannot regard it as a valid argument against its Foraminiferal affinities that its canal-system has a plan of its own.

That in its *general plan of growth* (to which the distribution of the canal-system is intimately related) *Eozoon* differs from all recent Foraminifera at present known cannot be regarded as a proof of its non-foraminiferal character by any who have fully studied the very wide range of forms which that group comprehends, including the numerous indefinite "arenaceous" types, whose import is only now beginning to be understood by those who have the best opportunities of studying them. He finds in the chambered structure of *Eozoon*, and in its general relations to the canal-system traversing its calcareous layers, points of essential conformity to the Foraminifera, which far outweigh the differences of detail by which Professor Möbius has been led to the opposite conclusion.

Hereafter he proposes to show that the "cumulative" argument in favour of the organic character of *Eozoon* is as strong as that of the human origin of the "flint instruments." Any one of the fractures that has given to these their characteristic forms, *might* have been accidental; and yet it is impossible to conceive that any number of such flints can have been so shaped "by accident."

Peridinium and Gymnodinium.*—Dr. G. Joseph, in describing the "Grotten-Infusorien," gives a valuable account of the history of the cilio-flagellate forms which have been known under these two generic names.

The Peridinia of fresh water are distinguished by a differentiation of the outer layer of their body-substance, which takes on the form of a smooth or a plated carapace. The oval body is convex on its dorsal, and more or less flat on its ventral surface. The

* 'Zool. Anzeiger,' ii. (1879) p. 114.

body is divided into two halves by a groove, and the hinder half is provided with a flagellum; the anterior edge of the groove carries fine, short, and closely approximated cilia, and the groove is, on the ventral surface, crossed by a non-ciliated longitudinal groove, which extends along the more posterior region, and the flagellum, when at rest, lies in this groove. These and other details were distinctly made out in small transparent forms, which have hitherto been regarded as *Gymnodinium*. Examined during growth, the carapace was observed to lose its simple character and to become plated, forming at last some five-and-twenty pentagonal pieces, which were connected together by the new cuticle, which could be seen between them; this is the form of *Peridinium*, and in this stage the creature was observed to be sexually mature. The double contour of the covering plates, which may be sometimes observed, is shown to be due to one plate underlying another, and as having been formed into a plate by a bursting of the cortical portion subsequent to that by which the first set of pentagonal plates was formed.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Division of the Pollen-grain in Angiosperms.*—Botanists have hitherto generally believed that the processes which take place within the pollen-grain before pollination are essentially different in Angiosperms and Gymnosperms. In Gymnosperms it has long been known that a division takes place of the contents of the pollen-grain into one large cell from which the pollen-tube is produced, and several smaller cells which take no part in any further process, and have hence been called vegetative cells. An analogy is thus traced with the development of the microspore of *Isoetes* and *Selaginella*, the large fertile cell being regarded as homologous with the antheridium, the vegetative cells with the male prothallium. In Angiosperms, on the contrary, it was believed that the pollen-grain remained perfectly unicellular up to the time of pollination. It is true that Reichenbach and Hartig detected and figured pollen-grains with two nuclei, a structure which was confirmed by Strasburger. But it has been reserved for F. Elfving, of Helsingfors, in a most careful and admirable series of experiments carried on in Strasburger's laboratory at Jena, to demonstrate for the first time that a cell-division takes place normally within the pollen-grain in Angiosperms corresponding to that of Gymnosperms. The following are the main results arrived at:—

At a certain stage of development, before pollination, the pollen-grain of Angiosperms divides into two cells, a larger and a smaller one; the latter, or "vegetative" cell, may again divide into a two- or three-celled body.

This latter vegetative cell (or cells) is separated from the large cell only by a protoplasmic membrane, though in a few cases a distinct wall (of cellulose?) is formed.

* 'Jenaische Zeitschr. Naturwiss.,' xiii. (1879) p. 1.

The pollen-tube is developed from the larger cell. In certain cases the vegetative cell (or cells) takes no part in this process, the nucleus and other contents of the larger cell only passing into the tube. But usually the separating wall is resorbed. It may disappear almost immediately after the division, but in most cases endures for a certain time; the entire vegetative cell (or cells) separates itself from the inner wall of the pollen-grain, and is thus surrounded by the larger cell, assuming a peculiar spindle or crescent shape. The vegetative cell may remain for a longer or shorter period in this condition; or its nucleus divides, and fresh cells are thus formed by free cell-formation. In both cases the protoplasmic membrane is finally resorbed, either in the pollen-grain itself, or after the vegetative cell has passed into the pollen-tube. After the disappearance of this membrane, a further division of the naked nucleus may take place, either in the grain or in the tube. The nuclei often have a peculiar form.

Except in the case of the Cyperaceæ, no division of the nucleus of the larger cell was observed.

No definite order is usually maintained in the passage of the contents of the pollen-grain into the pollen-tube. The nuclei are absorbed sooner or later, but always before fertilization. The larger cell and its nucleus appear to be of greater importance in impregnation than the others. This may be inferred from the facts that it is the larger cell that develops into the tube, and that there are circumstances in which the nucleus of the larger cell always takes precedence in the movement, while the opposite case was never observed; and even in those plants in which this precedence is not constant, it is still most usual; as also from certain cases where the vegetative cells remain in their original position within the pollen-grain, and do not enter the pollen-tube.

The observations were made mostly on monocotyledonous plants belonging to the orders Orchideæ, Liliaceæ, Irideæ, Cyperaceæ, &c.; but some also on dicotyledonous plants, as *Lathyrus sylvestris*, *Plantago media*, *Hypericum calycinum*, &c. The preparations were made almost entirely with a one per cent. solution of osmic acid. The author found it, however, almost indispensable to use some pigment after fixing the preparation with osmic acid; and for this purpose he found the best to be a solution of carmine to which some glycerine was added. By this means, after about twenty-four hours, preparations were obtained which left scarcely anything to be desired as to clearness.

In order to see the growth of the pollen-tube, recourse must be had to artificial culture; and for this purpose many sorts of solutions were used, and of very different degrees of condensation; but in the end the author came back to a simple solution of sugar. In some cases weak solutions were required, and in others strong ones. The culture was generally made in the dark, and at a summer temperature, but some grown in daylight succeeded admirably.

On three plates the different forms to be met with in some twenty-three species of plants are represented.

Anatomical and Physiological Study of Nectaries.*—*Critical Considerations.*—Messrs. Darwin, Müller, Lubbock, &c., consider that the nectariferous tissues accumulate sugar in order to attract insects and effect cross-fertilization. They moreover describe all floral arrangements as being contrived to produce this result in a definite manner. M. G. Bonnier concludes, on the contrary, from his numerous observations, carried on since 1871 in the Alps, France, Pyrenees, Sweden and Norway, &c., that the size of the corolla, the development of colour in the floral organs, the perfume, and the spots and striæ on the corolla, are not correlated to the formation of nectar, and that they are independent of the frequent visit of insects.

In diœcious nectariferous plants the insects do not go to the male flowers first, though they are more visible than the female flowers.

The same flower may be visited in many ways by the same insect.

The form of the flower may be altered without any sensible modication in the visit of the insects; they very often gather nectar without fertilizing the flowers. The insects that visit the same flower vary according to the quantity of nectar it produces, and those of the same species differ greatly in different countries.

We cannot conclude from the facts observed that the colour, perfume, and corolla of flowers are disposed so as to exclude insects not adapted for cross-fertilization.

In short, there is no ground for admitting a definite reciprocal adaptation between insects and flowers.

Moreover, nectaries frequently exist without any *external nectar.* Numerous nectariferous tissues are also found unconnected with flowers. The rôle of these nectaries is unknown.

The preceding remarks show that the modern theory on the rôle of the nectaries is insufficient.

Anatomical Considerations.—By *nectariferous tissue* M. Bonnier means all tissue in contact with the exterior, in which the different kinds of sugar accumulate in considerable proportion.

He examined the sacchariferous tissues by means of cupro-potassic tartrate, polarized light, and fermentation, as well as with absolute alcohol, and microscopically, in more than three hundred genera, and came to the following conclusions.

There is always an accumulation of saccharine substances, particularly saccharose, near the ovary, and often a localization of it in certain parts of the appendicular organs.

The structure of the nectaries is very variable.

Physiological Considerations.—When the epidermis of the nectariferous tissue is furnished with stomata (which is most commonly the case), it is chiefly by these openings that the liquid is emitted; in other cases it may pass through the non-cuticularized membranes, or by raising the cuticle.

We may conclude, all conditions being equal, 1st, that the quantity of liquid emitted by the nectariferous tissues increases with the quantity of water absorbed by the roots; 2nd, that it increases with the hygrometric state of the air. By combining the two influences,

* 'Comptes Rendus,' lxxxviii. (1879) p. 662.

M. Bonnier made plants (hyacinths, tulips, &c.) artificially nectariferous. Other experiments showed that the osmotic impetus of the roots, and the capillary force of the vessels, are not necessary to, though they accelerate, the emission of the saccharine liquid.

In settled fine weather the quantity of nectar emitted is at a minimum in the afternoon; it is the same with the proportion of water which it contains. In fact, the production of nectar is in direct relation to the transpiration of the plant.

The floral nectaries examined at different ages show that the maximum production of nectar is at the epoch in which the ovary finishes, and the fruit has not yet begun, its development. The proportion of saccharose contained in the tissue varies in the same way, whether emitted or not. There exists near to the saccharine tissues an inverting ferment, which transforms the saccharose into glucose, and abounds at the time when the fruit is about to develop. Finally, the whole or greater part of the accumulated sugars return to the plant; the floral nectaries contribute to the nourishment of the young fruit and the fertilized ovules, and the extra-floral nectaries to that of the neighbouring organ about to develop; at the same time the saccharose diminishes relatively.

The nectariferous tissues, whether floral or extra-floral, whether emitting liquid or not, constitute special nutritive reserves, in direct relation to the life of the plant.

Causes of the Change in Form of Etiolated Plants.*—In 1873 Professor Godlewski published in 'Flora' an account of his investigations respecting the formation of starch in chlorophyll-grains. In that memoir he stated that the changes in form which plants undergo in darkness are not due to the suspension of the assimilative process. In 1875 and 1877, he published in the Polish language two short notices of his further observations upon this subject, which he now fully recounts in the present paper.

Only the first series of his later experiments will be referred to now, namely, those bearing upon the question as to the relation of the assimilative process to the change of form in growing plants deprived of light. It is a general rule, to which there are some exceptions, that internodes grown in the dark are longer, and leaves are smaller, than those which develop in sunlight. In Pringsheim's 'Jahrbuch f. wiss. Botanik,' vol. vii. p. 213, Dr. G. Kraus has sought to explain the latter fact by the hypothesis that it is chiefly out of assimilated matter freshly formed in growing green leaves themselves that they expand to their full size, and hence the diminutive size of etiolated leaves is thought by him to be directly dependent upon the absence of the assimilative process.

In Professor Godlewski's experiments germinating plants were cultivated in an atmosphere deprived of its carbonic acid, some of them in light, others in perfect darkness, but under similar conditions of temperature and moisture. It was found that when the plants had exhausted the food stored in the seed and had ceased to grow, the total

* 'Bot. Zeit.,' xxxvii. (1879) p. 81.

weight of dry organic matter was the same in the green and in the etiolated plants. The plants which had grown in the light, but in air free from carbonic acid, and where assimilation could not take place, did not bear the slightest resemblance in form to etiolated plants. They were of perfectly normal habit.

Effects of Submersion on Aerial Leaves, and of Water on Floating Leaves.*—Previous experiments by E. Mer on the ivy, haricot, and Tropæolum, had led to the following conclusions, viz.:—

1. Throughout the whole submersion the leaves have no power of producing starch, and they rapidly lose that which they contained.

2. Their development is greatly retarded, and they never acquire their normal dimensions.

3. They die more or less rapidly, according to the species. This is generally preceded by the infiltration of the lamina.

Further investigations by the same authority show that the cause of the death of submerged leaves is not so much asphyxia as starvation, from the failure of the power to assimilate consequent on the diminished supply of oxygen. The perishing is also greatly accelerated by the infiltration of the tissues, which, however, does not usually take place until the starch has completely disappeared. Leaves of plants with bulbous roots suffer much less than others by immersion, because of the constant supply of assimilated food-material from the reservoirs. The infiltration is perceptible chiefly in the intercellular spaces, but, in order to reach these, water has first to penetrate the epidermis.

In the case of aquatic plants with floating leaves, M. Mer shows that these leaves are also killed, like aerial leaves, by submersion, and that the starch which they contain is produced entirely on the upper surface, and not from the carbonic acid dissolved in the water.

Absorption of Water by the Lamina of Leaves.†—The following results have been arrived at by E. Mer, in continuation of his researches on the effects of submersion on the leaves of plants:—

1. The lamina of leaves can absorb water, both when they are entirely submerged after having lost their turgidity, and when placed in contact with the liquid only by a portion of their surface, the other part remaining exposed to transpiration.

2. Absorption is more active by the lower than the upper surface, and more so in those leaves which have a thin than in those with a thick cuticle. In the former it is sufficient to suspend desiccation in the internodes and the remaining leaves which are not submerged, when these organs do not receive water from any other source; it is, however, not sufficient to preserve the turgidity of the roots. In the latter the absorption of water is not sufficient to recover the weight which they possessed before fading.

3. The absorption is not merely local, since it restores turgidity in the neighbouring organs. All the tissues of a plant are more or less capable of absorbing water. This can be proved in a variety of cases.

* 'Bull. Soc. Bot. France,' xxv. (1878) pp. 79 and 89.
† Ibid., p. 105.

4. The lamina of leaves does not absorb water when (1) they have retained their turgidity; at least it does not take place in the vicinity of organs which are actively transpiring; (2) when they have within their reach tissues containing abundance of water; when slightly withered they appear to prefer imbibing water from this source.

Movements of Growing Leaves and Petals.*—Dr. Carl Kraus has an elaborate and important paper on this subject in 'Flora.' The author mentions in the first place that these periodic movements are of two kinds:—those caused by unequally accelerated or retarded growth of different masses of cells; and those which are not dependent on growth, but on a transitory alternate elongation and shortening of certain masses of cells. The first kind are *movements of nutation;* to the second kind, which Pfeffer has made specially his study, he has applied the term *movements of variation.* His investigations have shown that every sensitive movement caused by decrease of light is followed by changes in position of the part affected, the extent of the oscillations depending on the degree of change in the amount of light. Alterations in the amount of light are, therefore, the chief cause of those movements. A secondary cause is a change in the amount of moisture in the air. On these two causes depend mainly the opening and closing of flowers. It is obvious that the "bifacial" structure of the flat, horizontal leaves of most dicotyledonous plants, combined with the fact that, as the leaf unfolds, the under surface is more completely exposed to the light than the upper surface, must bring about different conditions in these respects between the two surfaces of the leaf. The following are some of the special phenomena thus exhibited:—

1. Changes of position from decrease of turgidity. This is the ordinary familiar phenomenon of the withering of leaves or petals when the supply of moisture is cut off. In many plants, such as *Chenopodium album, Stellaria media, Nicotiana latissima,* &c., the loss of water is spread so rapidly from cell to cell that no perceptible difference is manifested between the upper and lower surfaces, and the leaves simply hang down; and the same is the case with the petals of *Solanum tuberosum* and *Convolvulus arvensis;* while those of *Silene noctiflora* roll themselves up inwards.

2. Changes in position from increased turgidity. For the changes under this condition the original paper must be consulted. Observations were made on the leaves of *Chenopodium album, Solanum tuberosum, Nicotiana latissima, Stellaria media,* and *Polygonum Convolvulus,* and the petals of *Convolvulus arvensis, Solanum tuberosum, Silene noctiflora,* and *Calendula pluvialis* and *officinalis.*

The cases of those Papilionaceæ of which the leaflets raise themselves erect in the evening, like *Trifolium pratense* and *incarnatum* and *Lupinus luteus,* and of those which are depressed in the evening, like *Lupinus albus* and *Phaseolus,* were subjected to careful investigation; and the mechanical causes of the various phenomena described are minutely discussed in the paper.

* 'Flora,' lxii. (1879) p. 11.

Disengagement of Heat which accompanies the Expansion of the Male Inflorescence of Dioon edule.*—This cycad has recently flowered abundantly in the hot-houses of the Botanic Gardens at Paris. The opening of the male inflorescence was attended by a strong and nauseous odour, coinciding apparently with the dehiscence of the anthers. M. Poisson has observed that this was accompanied by an elevation of temperature of at least 10° C.; and that the disengagement of heat is promoted by light, and is consequently more marked on the side exposed to light than on the shady side.

Spiral Cells in the Root of Nuphar advenum.†—M. Pihier notes in the root of this plant a single superficial layer of these cells, analogous, in their appearance and their situation, to those described by M. Chatin in the aerial roots of epidendral orchids. This structure, all the more exceptional in its character from its occurrence here in submerged roots, may be held to establish a new point of similarity between the Nymphæaceæ and the order placed by many botanists at the head of Monocotyledons as respects complexity of structure.

Structure of the Fruit of Conium maculatum.‡—M. Moynier de Villepoix has made a more careful examination of the structure of the fruit of the hemlock than has hitherto been conceded to it. He finds in the seed an abundant endosperm, as is usual in Umbelliferæ, formed of polygonal cells with thin walls, and containing grains of aleurone. This is bounded on the outside by two zones of brown cells which have long been known as especially characteristic of the mericarp of the hemlock. Thirdly, there is the pericarp, properly so called, in the parenchymatous tissue of which are the organs of secretion or vittæ, although the fruit of Conium is frequently described as being destitute of these.

Modifications which Starch undergoes from a Physical Point of View.§—F. Musculus thus sums up the results of a series of experiments:—

Starch can be obtained in the colloid or crystalloid state.

In the colloid state it is soluble in water, is coloured blue by iodine, is not diffusible, is easily converted into sugar by ferments and dilute acids, and readily passes over into a condition insoluble even in boiling water, and is then scarcely acted on by ferments or acids, and assumes a red or yellow colour under the subsequent iodine reaction. After treatment with concentrated sulphuric acid or soda-ley, the blue colour is again obtained by iodine, and ferments or dilute acids have a powerful action.

Crystalline starch consists of separate crystals which readily unite into plates, and then become gradually less soluble in water, so that crystalline starch behaves in this respect like colloid; on the other hand, it remains soluble in water of 50°–60° C., is diffusible, though with difficulty, and is readily acted on by ferments or dilute acids.

* 'Bull. Soc. Bot. France,' xxv. (1878) p. 253.
† Ibid., p. 163. ‡ Ibid., p. 166.
§ 'Bot. Zeit.,' xxxvii. (1879) p. 345.

The separate crystals are not coloured by iodine-solution, but such a solution assumes a red colour, which turns to violet and finally blue on evaporation.

A similar difference in the degree of molecular cohesion occurs also in the case of cellulose. On the one hand, the cellulose in certain cotyledons is a delicate tissue, coloured blue by iodine and acted on by diastase; on the other hand, it is a hard solid mass, as in cotton, the pith of the elder, &c., which undergoes change only after long-continued action of concentrated acids or alkalies.

Cellulose and starch present therefore many analogies, not only in their chemical, but also in their physical properties.

Rain of Sap.*—On the 22nd August, 1878, at 4 P.M., in calm weather, with a clear sky, and a temperature of 24° C. in the shade, M. C. Musset was struck by the evolutions of the gnats under the outspread branches of two trees, varieties of *Abies excelsa*. Round some yew trees (*Taxus baccata*), a lime tree (*Tilia platyphylla*), and two very old stumps of *Althæa frutex*, he noticed similar swarms of insects, but less numerous; under other trees there was not a single gnat. He then noticed an immense quantity of very limpid little drops falling in the form of fine rain, which became visible against the rays of the sun.

The phenomenon was observable for a fortnight, at any hour of the day, and often, by the light of a lamp, in the night.

If, on hot days, with a misty sky, the falling of the drops is not to be seen, it is easy to prove the reality of the fact by spreading a piece of dark-coloured silk material.

The following are briefly, in his opinion, the approximate causes of this phenomenon. At the end of summer and the commencement of autumn, vegetation gradually suspends its activity, the tissues become cuticularized, and consequently the transpiration decreases; but the sap continues to rise in the vascular bundles, and, being no longer utilized for the work of assimilation, its excess is poured out by the stomatic openings and the bordered pits, so peculiar to the cells and vascular fibres of the Coniferæ.

This aqueous sap is nearly insipid, perhaps slightly purgative, and colourless, but in a few days it assumes a pale amber tint.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Prothallium of Salvinia natans.†—Bauke has investigated the development of the unfertilized prothallium of Salvinia, a point left undetermined in Pringsheim's investigations. Sachs has already shown that of the two families of Rhizocarpeæ, the Salviniaceæ exhibit an intermediate stage between the other family, Marsileaceæ, and ferns, especially in reference to the structure of the fructification. The development of the unfertilized prothallium of *Salvinia natans* was thus followed out by Bauke. The power of division of the cells

* 'Comptes Rendus,' lxxxviii. (1879) p. 306.
† 'Flora,' lxii. (1879) p. 209.

of the apical ridge is limited. In the whole of its anterior portion cell-division has completely ceased when about four rows of archegonia have been formed. The conclusion of growth is always indicated by the pushing forwards of the archegonia close up to the cells of the apical ridge; they therefore appear to be directed towards the margin. Archegonia were never seen to originate from the cells of the marginal ridge. Since no further growth takes place in the anterior direction, the posterior cells on both sides of the ridge which are nearest the macrospore retain their power of division. There remains therefore on each side a zone of growth, increasing downwards, by the activity of which a relatively broad wing-like appendage is produced. In this zone of growth archegonia are continually being produced, and especially on the prolongation of the ridge of the prothallium; and since at the same time growth ceases gradually downwards in the marginal cells, new archegonia are also produced laterally towards the margin. Since the new archegonia are produced in acropetal succession, a further resemblance of the Salviniaceæ to ferns is here indicated.

Bauke has also made an additional observation on the formation of the ventral canal-cell of the archegonium. While the canal of the neck is at first filled with granular protoplasm, there is finally only a very small granular string left within the mucilage, the loss of mass being very striking. The formation of the mucilage is therefore a process of excretion or growth rather than simply of swelling. This indicates a similar origin of the mucilage to that in the case of ferns. No rhizoids were ever observed on the prothallium of Salvinia, such as occur in Marsilea.

Fungi.

Contribution to the Germ Theory.*—Dr. Robert Koch has published an important monograph on the ætiology of infectious traumatic diseases (Wundinfectionskrankheiten). The paper opens with a definition of the diseases treated of, and a review of the present state of our knowledge with regard to *contagium vivum*, and of the arguments for and against the doctrine. Then follows a description of the author's method of research, and then the most important part of the work, a detailed description of his exact and laborious experiments on artificial traumatic diseases.

1. *Septicæmia in Mice.*—Putrid blood or infusion of meat was injected under the skin of the back. Characteristic symptoms showed themselves, and the animals died in four to eight hours. No bacteria were found beyond those injected, so that in this case the disease was evidently due to a soluble poison (sepsin), and not to the agency of microphytes. In correspondence with this no effect was produced by very small injections (1 to 2 drops), except in about one-third of the cases. In these, different but equally characteristic symptoms supervened, death took place in about fifty hours, and a post mortem examination showed the blood to be crowded with small bacilli about 1 μ in length, which occurred in the vessels of all organs of the

* 'Untersuchungen über die Aetiologie der Wundinfectionskrankheiten,' Leipzig, 1878.

body, surrounding the red corpuscles and absolutely filling the white. Even $\frac{1}{10}$ drop of the blood thus affected was able to communicate the disease to another mouse, and the disease was, in fact, carried through seventeen generations. There seems little doubt that the bacilli are the actual contagium of this form of traumatic septicæmia. It is a curious circumstance that field-mice and rabbits were not susceptible to the disease.

2. *Progressive Tissue-necrosis (Gangrene) in Mice.*—In mice injected with decomposing blood there were sometimes found at the place of injection (in the subcutaneous tissue) micrococci, as well as the regular bacilli of septicæmia. These micrococci had a diameter of $0\cdot5\,\mu$, multiplied rapidly, and showed a great tendency to the formation of "chains." Lymph from the subcutaneous tissue infested with these was injected into a mouse's ear. The micrococcus-chains soon multiplied so fast as to interpenetrate the whole ear, the tissue of which became so changed as to be hardly recognizable; cartilage cells looked pale, as if treated with potash, and blood and connective-tissue corpuscles were no longer to be seen. It seems clear that the septicæmia-bacillus is a necessary forerunner of the gangrene-micrococcus. An interesting pure-culture experiment was tried. Field-mice, which, as stated above, are not susceptible to septicæmia, were injected with fluid containing both bacilli and micrococci. The former had no effect, the latter multiplied and caused death, and from the animals so affected both field and house mice could now be inoculated, the result being always gangrene and never septicæmia.

3. *Progressive Abscess-formation in Rabbits.*—Rabbits were injected with putrid blood. A flat, hard, lenticular infiltration was gradually formed at the place of injection, producing at last a fatal abscess in the subcutaneous tissue. The abscess was covered by a thin layer of micrococcus-zooglœa; its cheesy contents were finely granular, and contained no bacteria, but were probably derived from the zooglœa and from the enclosed dead tissues. The individual micrococci were $0\cdot15\,\mu$ in diameter. The blood of rabbits dying from this disease produced no infection, but the disease was communicated by injecting a little of the interior of the abscess rubbed up in water.

4. *Pyæmia in Rabbits.*—A rabbit was injected with fluid obtained by macerating mouse-skin in water. A purulent infiltration of the subcutaneous tissue resulted, accompanied by swelling of the spleen, morbid changes in lungs and liver, and peritonitis. Micrococci abounded in the affected places, occurring in the blood-vessels surrounding the corpuscles, and forming accumulations which sometimes quite obstructed the lumen. These micrococci are distinguished from those of gangrene and abscesses by not forming chains or zooglœa, and by their size ($0\cdot25\,\mu$). For inoculation, $\frac{1}{10}$ of a drop was sufficient, but not $\frac{1}{1000}$.

5. *Septicæmia in Rabbits.*—The animals were injected with a putrid infusion of meat. A purulent accumulation (jauchige Vereiterung) took place, and the subcutaneous tissue in the neighbourhood became filled with a watery fluid, containing large oval micrococci (diameter $0\cdot8$ to $1\,\mu$), which also occurred in the kidney and spleen.

Injection of 5 to 10 drops of the œdema fluid communicated the fatal symptoms.

6. *Erysipelatous Process in Rabbits.*—The ear was injected with mouse's dung, softened in distilled water. The organ became red, swollen, and flabby, and was found to contain large numbers of bacilli 3 μ in length and 0·3 μ in diameter. The author failed to communicate the disease to other animals.

After the description of these experiments, Koch devotes a few pages to splenic fever, and then sums up his results, and discusses their importance. For the first five cases there is complete, for the sixth partial evidence of parasitic nature. Infection is produced by so small a quantity of fluid, that toxic effects are quite excluded. For each disease the bacterium-form is distinct and unchangeable; this is the most important result of all. The living body is the best possible pure-culture apparatus.

Some former writers have stated that the virulence of the poison in these diseases increases constantly in successive generations; Koch considers that it increases up to the second, or latest the third generation, and then remains constant.

Nature of the Fur on the Tongue.*—The fur on the tongue is generally stated to consist chiefly of epithelial cells usually sodden and granular, though Robin, Kölliker, Billroth, and others have described fungi as existing in it or in the buccal mucus.

According to Mr. H. T. Butlin, Schizomycetes form the essential constituent of the fur.

On 68 healthy tongues examined, fur was found on all except one; and on 178 tongues of persons suffering from disease or accident, on all except two.

Microscopical examination of the results of scraping gave in nearly every instance the same results: (1) *Débris* of food and bubbles of mucus and saliva; (2) Epithelium; (3) Masses which appeared at first to consist of granular matter, but which are the glœa of certain forms of Schizomycetes.

That the last-named of these three is the essential constituent is proved by the fact that the quantity of the glœa depends roughly upon the quantity of fur, and that its position upon the tongue corresponds with that of the fur, both covering the tops of the filiform papillæ, but not usually lying between them.

In order to ascertain the true nature of the glœa, and to obtain it in a purer form, it was cultivated upon a warm stage (30°–33° C.). Several fungi were discovered, but only two of these were present in every instance, *Micrococcus* and *Bacillus subtilis*; and, as the glœa produced artificially was similar to that existing naturally in the tongue-fur, it is believed that fur is composed essentially of these two fungi. *Micrococcus* developed abundantly and rapidly, forming large masses of yellow or brownish-yellow colour. *Bacillus* did not develop, but existed in greater or less abundance in all the cases examined. Its development was probably prevented by the presence of other

* 'Proc. Roy. Soc.,' xxviii. p. 484.

developing organisms, from which it was found impossible to separate it. It appeared to be identical with the *Leptothrix buccalis* of Robin. Although it did not develop under artificial conditions, it is probable that development takes place freely upon the surface of the tongue. Its habitual occurrence there, and the presence of spore-bearing filaments, favour this view.

Besides these fungi, there were present, more or less constantly, *Bacterium termo*, *Sarcina ventriculi*, *Spirochæta plicatilis*, and a larger form of *Spirillum*. *Sarcina ventriculi* was frequently present, and generally developed quickly, forming large masses of a yellow or brownish-yellow colour. *Spirochæta plicatilis* occurred only in two or three of the specimens examined. *Bacterium termo* existed in some of the furs, and twice developed with such rapidity that the whole of the fluid was crowded with these organisms.

The slime between and around the teeth was found to consist of the same fungi as the tongue-fur, but the rods of bacillus were longer, probably owing to the disturbing causes being fewer.

When thin the fur can only be scraped off with difficulty, and always brings with it numerous fragments of the hair-like processes which form the terminations of the filiform papillæ. But when thicker, soft and moist, it can be removed in considerable quantity with ease.

Supposed Amylaceous Substance in Fungi.*—The entire group of Fungi are generally stated to be altogether destitute of both chlorophyll and starch. In his investigations of the Pyrenomycetes, M. Crié believes that he has detected an amylaceous substance in the asci of *Sphæria Desmazieri*. The young asci, having a length of from 0·005 to 0·007 mm., proceed from the hymenium of a perfectly closed perithecium, and have hard and very dark walls; they are simple cylindrical cells, formed from a homogeneous or finely granular protoplasm, enveloped by a single membrane. The existence at this period of an amylaceous globule is very perceptible, presenting the appearance of a simple point occupying the summit of the ascus. This globule, which is distinctly organized, increases gradually in size by intussusception, as can be proved by the iodine reaction, which shows also that it is composed of granulose. The globule appears to take no part in the formation or nutrition of the spores, but is expelled from the summit of the ascus immediately before their dissemination. It appears to consist of true starch, but is formed in perfect darkness, from a protoplasm destitute of chlorophyll, and insoluble in the cell-sap. He proposes for it the term *amylomycine*.

M. de Seynes, however, contests the view of this structure taken by M. Crié.† He points out that in many of the Sphæriaceæ the asci are composed of two utricles or membranes, one enclosed within the other. The inner membrane is sometimes permanent and bears the spores on its outside when it bursts the outer membrane. Sometimes it is transitory, and disappears as the spores are being formed, when it is difficult of detection. Berkeley and Broome, the first describers

* 'Comptes Rendus,' lxxxviii. (1879) p. 759.
† Ibid., p. 820.

of the *Sphæria Desmazieri*, describe this inner membrane as being furnished with an oblong process at the tip; and it is this "oblong process" which M. Crié has mistaken for an amylaceous substance. When first formed it is in intimate connection with the membrane of the ascus, and remains attached to it after the formation of the spores; the narrow neck which unites them becomes thicker, so that the corpuscle, at first spherical, becomes pear-shaped. The same structure, with slight variation, was observed in two allied species, *Rosellinia Aquila* and *R. Thelena*.

Cellules en boucle.*—The peculiar cells found in some fungi and known as "cellules en boucle" or "Schnallenzellen," already described by Hoffmann and de Bary, have received further attention from M. de Seynes.

They are distinguished by the presence of a rounded appendage placed here and there on their external wall. This is a cylindrical cellular formation, very short and of small diameter, proceeding from the cell below a septum, and united with it either in its entire length or only by its summit. The cavity of this small cellular excrescence usually remains in communication with that of the cell from which it emanates, but is sometimes separated by a septum. The writer believes these structures to be simply an arrested condition of cells in the act of multiplication. They are well shown in the pseudo-parenchyma of the receptacle of Fistulina.

Anthracnose of the Vine.†—M. Cornu gives a full description of the disease of the vine known as "anthracnose," from the neighbourhood of Narbonne, where it is committing great ravages. The cause of the disease is a fungus considerably smaller than the oidium, but committing even greater devastation. It appears to be strictly annual, and makes its appearance on the green organs during the season of fine weather.

Aschotricha.‡—M. Bainier describes two species of Aschotricha grown on damp linen.

The first is very abundant and of an elegant appearance. In the centre are the naked asci; at first elongated, subsequently round, and so small as to be difficult to distinguish. Each contains eight smooth ascospores, oblong and yellow when mature. Dispersed among the asci are paraphyses, black filaments, the extremities of which are finally transformed into a segmented club-shape. The paraphyses branch and anastomose. The conidia have no special supports.

The second species, less common and often much smaller, is distinguished at first sight by the absence of the club-shaped extremities of the paraphyses, which also do not anastomose. The conidia are not round, but have somewhat the form of little corkscrews.

Development of Sclerotia.§—M. Cornu has followed out the researches of Tulasne and Leveillé as to the part played by the "sclerotium" in the development of certain fungi, confirming on the whole the previous observations.

* 'Bull. Soc. Bot. France,' xxv. (1878) p. 95.
† Ibid., p. 227. ‡ Ibid., p. 245.
§ Ibid., p. 176.

The fungus which gives rise to the "sclerotium complanatum," not uncommon in the neighbourhood of Paris, is *Clavaria juncea*, while the species which grows from the development of the sclerotium is a very delicate one, placed in an allied genus, and known as *Typhula phacorrhiza*, which was, however, described by Desmazières as a variety of *Clavaria juncea* parasitic on the sclerotium. The "sclerotium varium" was found to develop into a Peziza allied to *P. tuberosa*. The sclerotium which gives rise to *Agaricus cirratus* is "s. subterraneum var. truncorum." The "sclerotium varium" causes a destructive disease in Jerusalem artichokes.

New Genus of Sphæriaceæ.*—Some years ago M. de Seynes gathered in a garden in the neighbourhood of Montpellier a twig of wood, on which were black elevations caused by the attacks of a fungus belonging to a genus new to science, to which he gave the name *Eurytheca monspeliensis*. While belonging to the Sphæriaceæ it appears to present some characters intermediate between that family and the Tuberaceæ. The asci are placed in considerable numbers side by side in the tissue of the stroma; they are of an elliptical form, with transparent walls, and measure about 0·04 to 0·055 m. The spores are large, 0·025 to 0·03 m. in length, the number in each ascus varying between four and eight, as is frequently the case in the Tuberaceæ. There are no paraphyses.

Specific Differences among the Uredineæ.†—The *Juniperus Oxycedri* of the Mediterranean region is often attacked by a Podisoma, which has generally been regarded as identical with the *P. Juniperi* so abundant on the common juniper. M. Cornu has succeeded in studying this fungus by cultivating it, in its form of *Rœstelia lacerata*, on the leaves of the hawthorn, and has fully established its identity.

The spermogonia appeared abundantly at the end of fifteen days or less. It is probable, however, that many Æcidia which appear identical are not so in reality. De Bary has shown that the species parasitic on the haricot and the common bean, so alike externally, are not identical, but differ from one another as greatly as the *Uromyces Phaseolorum* and *U. Fabæ* from which they proceed. It is much more difficult to distinguish from one another the æcidial than the teleutospore forms; and it is no doubt for this reason that the number of species of Puccinia is much greater than that of Æcidium, even when from the former are excluded those which, like *P. Dianthi* and *P. Malvacearum*, reproduce themselves directly without any alternation of generations. Of two hawthorn-bushes on which the spores of the Podisoma were sown, one perished entirely, the other appeared to die all except a single bough, which, when the plant was placed in a greenhouse, gave birth to a branch of very peculiar structure, with short sessile leaves and axillary branches, the whole of which was strongly infested with the Rœstelia, appearing in February, far from its normal time of year. The parasite was feeble, and pro-

* 'Bull. Soc. Bot. France,' xxv. (1878) p. 87.

† Ibid., p. 221.

duced but a small number of spermogonia. This shows that although the Rœstelia is strictly annual, the mycelium may retain its vitality for a time in the tissue of the host.

Neovossia, a New Genus of Ustilagineæ.*—Von Thümen has detected in the ovary of *Molinia cærulea*—a grass on which no parasite of the kind has hitherto been observed—an ustilagineous fungus, which he makes the type of a new genus nearly allied to *Tilletia*, and describes under the name *Vossia Moliniæ* (subsequently altered to *Neovossia*, the former name having been already appropriated).

The mycelium consists of slender hyaline hyphæ, 4 to 5 mm. thick, not distinct at the apex, but forming a pseudascus or gelatinous follicle subpersistent around the mature spore, with a rather long cormoid process; the spores are dusky, and ellipsoidal or ovate. The origin of the spores at the ends of the hyphæ, and their formation in the gelatinous sac, are very characteristic, as well as the remaining of the spores within this sac even when ripe; while those of *Tilletia* present at the same age no trace of the gelatinous layer which previously enveloped them, but are perfectly free.

Injection of Bacteria into the Blood without any Toxic Effects.†—Professor Livon states that he has injected into the femoral or jugular veins of various dogs different liquids in a state of putrefaction—bile, urine, &c.—and containing a large quantity of *Bacteria*, without any other result than a certain amount of lassitude; the only change in the blood was an augmentation in the number of the white corpuscles; autopsy revealed no lesions. We draw attention to these statements chiefly because it does not seem to be as generally understood as it should be, that ordinary atmospheric bacteria do not set up fermentative changes in the *healthy living* organism; *Bacillus* will produce splenic fever in healthy organisms, but these forms require for their perfect development free exposure to oxygen, which is very far from being the case with *Bacterium termo*.

Anthrax and its Cause.‡—M. Paul Bert states that the blood of animals suffering from anthrax ("charbon"), when submitted to great pressure of oxygen, retains its mortal capabilities for ninety-nine hours, but no "bacteria" were seen; similar blood, treated with three to four times its volume of strong alcohol, gave just the same results; and he concludes that the bacteria are neither the cause nor the "necessary effect" of the disease, but that its virus is of the same nature as that of cow-pox or of glanders. He further states that the blood of the dog suffering from the disease is not poisonous to another dog or to the guinea-pig.

M. Leflaive, speaking at the same "séance," stated that he believed he had shown that in the Herbivora the poison resulted in a general affection of the whole system, while in man it only gave rise to a local affection, the blood not containing the virus, and being therefore incapable of propagating the disease. What obtains in man appears also to M. Leflaive to obtain in the Carnivora; in which case we get

* 'Oesterr. Bot. Zeitsch.,' xxix. (1879) p. 18.
† 'CR. Soc. Biol.' for 1877 (1879), p. 355. ‡ Ibid., pp. 19, 20.

an explanation of Professor Bert's results. At a later meeting* M. Bert stated that the results of some experiments on a guinea-pig, which had been poisoned with the morphological element ("bacterium") of anthrax poisoning, and whose blood lost completely its toxic effects after a week's treatment with compressed oxygen or concentrated alcohol, had led him to believe that there were two maladies confounded under the name of the "charbon"; that one is *virulent* and owes its origin to the matter precipitated by alcohol, while the other is merely *micro-parasitic;* it is possible that the two states may coexist in the same animal, but, where the poisoning has been of the virulent type, Bert found but few bacteria; in the guinea-pig it was noticed that the "virulent blood" killed in ten to twelve hours, and the blood-corpuscles were crenulated, while with the "bacterian blood" death occurred after thirty to thirty-six hours, and the corpuscles retained their original character.

The volume already cited also contains (p. 442) an account of a pathological investigation on the human subject; the patient was a carrier of meat who had cut his chin with a razor; during life a drop of blood revealed the presence of long "bacteridia" ($\frac{1}{58}$ mm. in length). The patient exhibiting a very low temperature (33° C.), the respiratory gases were examined, and it was found that he, a man weighing 80 kilogrammes, absorbed 7·924 litres of oxygen, and gave off 6·300 litres of carbonic acid in an hour; in other words, only about one-third of the healthy quantity of oxygen was inspired. In pursuance of the subject (p. 465), M. Regnard gives an account of the investigations which, with the aid of another colleague, he had made on a dog; here again the results of anthrax poisoning were a diminution in the amount of oxygen absorbed and of carbonic acid exhaled, together with a great fall in temperature, and the presence of a quantity of bacteria in the blood. Previous to inoculation with the anthrax poison, the blood of the dog absorbed 20·4 c.c. of oxygen per 100 grammes, while after poisoning the same quantity of blood absorbed 26 c.c.

Lichenes.

Lichenological Review.—The 'Revue Mycologique' is in future to deal with Lichens as well as Fungi, the editor being of opinion that the change is justified on account of "the points of contact which in certain genera so intimately unite the Lichens to the Fungi, and which are so evident even to observers the most disposed to defend the autonomy of Lichens as a distinct family, that they have not hesitated to declare in their writings that it was difficult to say where the Lichens ended and the Fungi began."

Algæ.

Power of Algæ to resist Cold.†—At a recent meeting of the Botanical Society of France, M. Cornu stated that he had seen several Chlorophyceæ, and especially Hydrodictyon, growing beneath ice. *Palmella hyalina* produced myriads of zoospores in a vase filled

* 'CR. Soc. Biol.' for 1877 (1879), p. 317.
† 'Bull. Soc. Bot. France,' xxv. (1878) p. 79.

with melting ice. Hæmatococcus vegetates at very low temperatures, even beneath ice.

Marine Algæ of the Gulf of Naples.*—P. Falkenberg gives a list of the marine algæ found at Naples, which will be exceedingly useful to the student of these forms who visits that region: the most complete work on the subject is very old, inasmuch as it was published in 1823—the 'Hydrophytologia Regni Neapolitani' of the famous Delle Chiaje.

The systematic portion of the essay is based upon Agardh's work on these forms; but there is also given in addition, notes on the times at which the algæ were found and of their times of fructification, while the localities of the rarer forms are also indicated. The list contains the enumeration of six algæ from Messina, which are not mentioned in Langenbach's list; some of these are new to the flora of the Mediterranean.

New Diatoms.†—P. Richter records two new fresh-water species of Diatomaceæ belonging to the genus *Homœocladia*, hitherto known as an almost entirely marine genus, which he calls *H. germanica* and *H. conferta*. They were found in a mill-stream near Leipzig, growing amongst Cladophora, within reach of the spray of the mill-wheel. The ground in the neighbourhood is strongly impregnated with salt.

Terrestrial Diatoms.‡—M. J. Deby recalls the inquiry of Ehrenberg § as to how it was that amongst the 400 species of diatoms found in the environs of Berlin, the two species which were most common in the atmospheric "dust" of all parts of the world, and at all elevations above the level of the sea, *Eunotia* (*Nitzschia*) *amphyoxis* and *Pinnularia borealis*, and which were also those met with most frequently in dust deposits at Berlin, were of the greatest rarity in a living state on the ground. He points out that few naturalists have occupied themselves with the search for diatoms outside their usual habitat in the sea or fresh water, with the exception of the late Mr. Walker Arnott, in whose collection are two gatherings obtained from moss growing on elms at Ulverston and in Perthshire. Mr. C. Johnson, of Lancaster, and the Rev. — Cresswell, of Teignmouth, have also made similar collections.

The following were the species obtained:—*Orthosira mirabilis*, *O. spinosa*, *Navicula mutica*, *N. pusilla*, *Pinnularia borealis*, *Nitzschia amphyoxis*, *Amphora affinis*, *Achnantidium coarctatum*.

These species, and probably many others, M. Deby considers to be essentially *muscicole*, living habitually on trees and in other places exposed to atmospheric vicissitudes; and he recommends the methodical washing of mosses wherever found, with a view of forming a list of Bacillaria which they contain in a *living state*. The presence of these species in the mosses of trees explains the fact of their presence

* 'Mitt. Zool. Stat. Neapel,' i. (1879) p. 217.
† 'Hedwigia,' xviii. (1879) p. 64.
‡ 'Bull. Soc. Belge Micr.,' v. (1879).
§ 'Uebersicht der seit 1847 fortgesetzten Untersuchungen, &c.' (1871) p. 102.

in the atmospheric dust without being found in a living state in adjoining water; and thus Ehrenberg's question is answered.

It is very possible that these diatoms belong to those in which the phenomena of deduplication, conjugation, and formation of spores are the most active, rapid, and easy to follow, and it is on this account that the study of *terrestrial* diatoms deserves attention.

The Rev. George Davidson, of Scotland, told M. Deby that for several years he has searched mosses for diatoms, and has found that the mosses growing at the foot of elms on the side exposed to the north furnish the greatest number.

MICROSCOPY, &c.

Method of preserving Infusoria, &c.*—M. Certes repeats in the 'Journal de Micrographie' the account of his observations, which have already appeared in the 'Comptes Rendus,'† to which he adds the following remarks:—

To obtain good preparations the following conditions must be fulfilled.

1. The absence of any movement of the cover-glass which could crush the Infusoria.
2. *Rapid* action of the osmic acid and *complete elimination* of the reagent as soon as the desired action is obtained.
3. *Slow and progressive* action of the colouring reagent, whatever it is, and elimination of it by glycerine.
4. *Very slow* substitution of the pure glycerine for the diluted and coloured glycerine.
5. *Hermetical* sealing, which cannot be obtained either with paraffin or with sealing wax dissolved in alcohol, or with Canada balsam if the margins of the preparation are not perfectly dry.

Hæmatoxylic Eosin and its employment in Histology.‡—It is known that eosin, soluble in water, colours the protoplasm of the cell elements, without having any selective action for the nuclei, so that when we wish to bring out these latter in a preparation coloured with eosin, recourse must be had to the method of double colouring proposed in 1876 by Wissotsky, a method which is long and requires several successive washings, which easily leads to the deterioration of the sections. Moreover, alcoholic or aqueous solutions of eosin precipitate that of hæmatoxylin prepared after Boehmer's classic formula.

M. J. Renaut, having remarked that eosin in an aqueous or alcoholic solution does not precipitate the hæmatoxylin of Boehmer's liquid, when the mixing is effected in the presence of neutral glycerine, conceived the idea of employing a liquid prepared in this manner. He mixes one part, by volume, of neutral glycerine and one part of a saturated solution of eosin in alcohol or water (according as pure eosin or eosin à la potasse is used). There is then added drop by drop hæmatoxylin prepared according to Boehmer's formula until the

* 'Journ. de Micr.,' iii. (1879) p. 242.
† See this Journal, ii. (1879) p. 331.
‡ 'Comptes Rendus,' lxxxviii. (1879) p. 1039.

green fluorescence of the mixture is scarcely visible. The filtered liquid gives a violet solution, which he calls *hæmatoxylic eosin*, and is employed in the same way as picro-carminate of ammonia in mounting preparations in glycerine or in Canada balsam. In the latter case the dehydrating is effected with alcohol charged with eosin and clarified with oil of cloves similarly charged.

Preparations made after the action of osmic acid or chromic solutions colour very well with this reagent, showing very regular differentiations. The nuclei are tinted violet, the connective tissue pearl-grey, the elastic fibres and the blood-corpuscles dark red, the protoplasm of the cells and the axis cylinders of the nerve-tubes a very intense light rose, &c.

In treating sections of the salivary glands of *Helix Pomatia*, the author discovered two kinds of cells—the one secreting mucus and colouring an intense blue, the other secreting a special matter distinct from mucus and colouring rose; this distinction is not observable when other colouring matters are used.

In sections of the salivary glands of mammals, and particularly of the Solipedes, the same fact is, remarkable to say, presented. In each acinus (from an ass) *the clear cells which secrete the mucus were coloured pale blue;* the nucleus buried at the base was coloured violet. The *crescent* cells of Gianuzzi, that is, *the cells which secrete the salivary ferment, were coloured a deep rose* and showed a violet nucleus contained in the centre of the protoplasmic mass.

Brösicke's Staining Method.*—Dr. G. Brösicke, of Berlin, recommends a combination of osmic acid and oxalic acid for staining the tissues, instead of osmic acid alone.

Small pieces of the tissue, or prepared sections, are placed for an hour in one per cent. osmic acid solution, and then carefully washed to remove all superfluous acid. They are then immersed for twenty-four hours or longer in a cold saturated aqueous solution of oxalic acid (one to fifteen), and are ready for examination in water or glycerine.

The result is that while certain substances, such as mucin, cellulose, starch, bacteria, the outer coat of certain fungi, &c., are scarcely at all coloured, other tissues, such as the vitreous humour, the substratum of the cornea, the walls of the capillaries, and various intercellular connective tissues, appear of a bright carmine; and muscular fibres, tendon, hyaline cartilage, the outer fibrillary substance of decalcified bone, and most of the tissues rich in albumen are stained a darker carmine. The grey substance of the central nervous system, most nuclei, and many cells, assume a dark Burgundy red tint. In all these cases, however, each particular tissue is stained a slightly different shade, so that it can be readily distinguished from its neighbours.

None of the objects treated by this method swell up or exhibit signs of internal coagulation. The oxalic acid produces darker or lighter shades in proportion to the length of time the specimen had

* 'Sci.-Gossip,' No. 175 (1879) p. 160.

previously been immersed in osmic acid, and if the latter has once completely blackened the tissue, the oxalic acid is powerless afterwards to redden it. Mixed solutions of osmic acid and oxalic acid stain proportionally to the relative strength of each. The chief drawback to this method is the small penetrating power of osmic acid, which prevents the whole thickness of a specimen from being equally stained.

Method of examining Living Cells of Larva of Newt, see p. 692.

Undescribed Microscopes.—We believe that the following Microscopes have never yet been described in any English treatise or journal. We propose to add from time to time the descriptions of any other extant forms which present any specialty, and have not hitherto been described in this country.

Fig. 1 represents the "*Microscope nouveau grand modèle renversé avec miroir argenté*" of Messrs. Nachet.

If the eye-piece of a Microscope is removed considerably from the objective, the image is of course largely increased, but to obtain the full advantage, it is necessary that the eye-piece should be of increased diameter. The weight of this and the long tube presents, however, a practical difficulty in addition to the fact that the observer is so far from the stage that it is impossible for him to manipulate properly.

To avoid these difficulties, M. Nachet conceived the idea of the Microscope represented in Fig. 1.

A strong tripod base supports a hollow brass column, the upper end of which is closed by a plate with a central hole, and to which is fixed a socket in which the tube carrying the objective A is moved by the milled head B forming the coarse adjustment. A fine adjustment is obtained by means of a second tube moved by the milled head V.

To the side of the column is soldered another tube (placed obliquely as shown in the figure), the interior of which is in communication with that of the column by an elliptic opening and having the eye-piece at the upper end. At the bottom of the column is placed a plane mirror silvered on its upper surface, and inclined at such an angle as to be perpendicular to the line bisecting the angle formed by the two tubes, so that all the rays from the objective pass to the eye-piece. The mirror does not appreciably deteriorate the image, the loss of light being insignificant. The distance of the eye-piece from the objective is 90 cm., and very large amplification can be obtained.

The stage is supported above the objective on three supports, and is supplied with movements by G and D. Above the stage is a "super-stage" C (which can be turned aside from the Microscope) for illuminating apparatus, and over that the mirror with universal movements, supported on an upright rod, which can be moved round the summit of the column.*

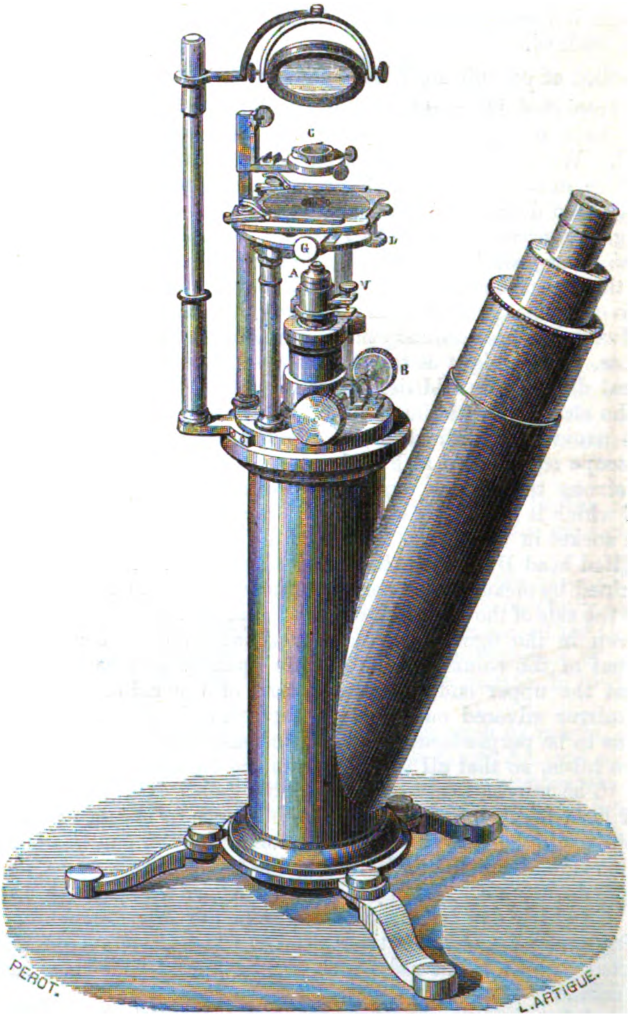
One of these instruments (from Mr. Crisp's collection) was exhibited at a recent soirée of the Quekett Microscopical Club. It was first exhibited at the Vienna Exhibition.

* Cf. Robin's 'Traité du Microscope,' 2nd ed. (1877) p. 62.

Fig. 2 represents the *Portable Demonstration Microscope* of Messrs. Nachet, which is very handy and convenient for class demonstration.*

It consists of a tube carrying the objective and eye-piece, which

Fig. 1.



slides within another attached to a handle by means of which the Microscope is held by the observer and directed to the light. To the handle is fixed a rod which carries the stage and illuminating apparatus.

* Cf. loc. cit., p. 81.

A speciality of the stage is that the object is fixed to its *under* side, so that no change of focussing is required with preparations mounted on slides of varying thickness. The coarse adjustment is made by sliding the tube carrying the objective through the outer one, and there is in addition a special fine adjustment moved by a screw close to the objective.

By means of the handle and the fork at the end of the rod which carries the stage, the instrument can be rested on the table without any danger of injuring the slide.

Fig. 2.

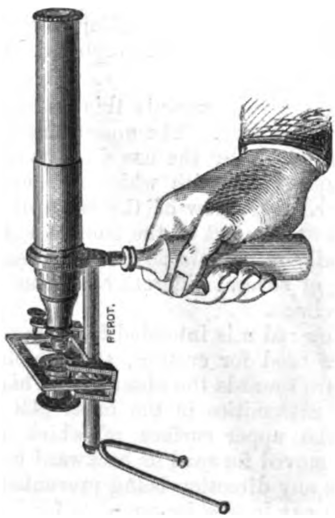
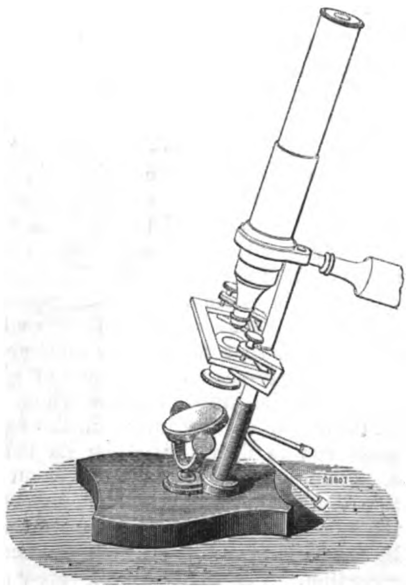


Fig. 3.



If in a preparation any point difficult to find is required to be shown, the Microscope can be fixed in the base which carries a mirror (shown in Fig. 3), and the preparation examined in the ordinary way.

This instrument will be shown at the next meeting of the Society.

Novel Method for Focussing.*—The Société de Biologie of Paris devote a page of their 'Comptes Rendus,' just issued, to a description by M. d'Arsonval of an arrangement which he has devised for focussing, "without touching either the object or the Microscope." The inventor states that he discovered the method several years ago, but neglected to communicate it, though at the same time he wishes it to be understood that he makes no claim for priority.

The idea was suggested to him by the observation that if an object is viewed through a parallel plate of glass, it will appear the nearer

* 'CR. Soc. Biol.,' xxix. (1877, pub. 1879) pp. 124–5.

as the plate is thicker. He accordingly arranges a layer of liquid between the objective and the eye-piece, the tube which carries the eye-piece being closed by a piece of glass, above which is a small tube communicating with a syringe full of water. On pushing the piston, water is injected between the objective and the eye-piece, and it is thus possible to vary the thickness of the layer of water to the extent of the whole distance which separates the two.

The method enables thicker cover-glasses to be used, and is available with the most powerful immersion objective, in which it differs from the arrangement of M. Govi (who placed a horizontal glass vessel of water between the object and the objective, and varied the thickness of the layer of water), that being only applicable to Microscopes which have a focal distance of at least 1·01.

The method may also be very conveniently used, according to the inventor, for photography, as coloured solutions may be employed to give monochromatic light.

Roy Microtome.*—The woodcut (Fig. 4) represents this instrument in natural size, the design of Dr. C. S. Roy. The object aimed at is simply to combine the accuracy gained by the use of a good microtome with the simplicity and convenience with which sections can be cut with the unsupported razor, not a few of the best histologists having abandoned microtomes on account of the trouble and waste of time occasioned, more especially in pathological work when a few sections are required from each of several different specimens, or from different parts of the same specimen.

The horse-shoe shaped piece of glass rod *a* is intended to support and guide the knife or razor which is used for cutting, and which glides on the surface turned in the figure towards the observer. This glass rod is firmly fixed by its two extremities in the brass plate *b*. The smaller brass plate *c*, on the upper surface of which a thin layer of cork is cemented, can be moved forward or backward by the fine-threaded screw *d*, movement in any direction being prevented by the form of the bed which has been cut in the larger plate for its reception. The small thumb-screw *e* serves to connect the movable plate with the end of the larger screw *d*, and admits of the plate being removed when desired.

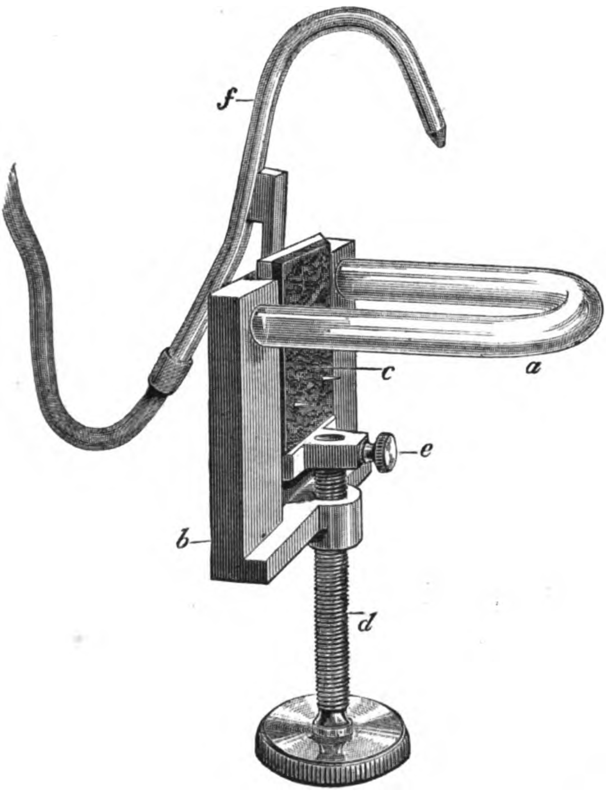
Fastened underneath the larger plate in such a way that it can be readily removed and replaced is the bent brass tube *f*, which is intended to admit of a few drops or of a constant flow of spirit being projected on the knife and specimen while sections are being cut. This tube is connected with a test-tube arranged after the principle of a Wolff's bottle, and which can conveniently be suspended by a thread from the button-hole. A caoutchouc tube, with a mouthpiece of glass attached to it, permits of air being blown into the test-tube, forcing out a part of the contained spirit or water by the tube *f*.

The method of using the instrument is exceedingly simple. The portion of tissue to be cut is imbedded in an appropriate imbedding mass, and is then placed upon the movable plate *c*. Upon this it is held fixed by the thumb of the left hand, the index and middle fingers

* 'Journ. Physiol.' (Foster), ii. (1879) p. 19.

of which pass under the plate *b*, and exert a counter pressure. Both the specimen and the microtome are thus held in the same manner as one holds the specimen when no section-cutter is employed. The plate and imbedded specimen are pushed gradually forward by turning the milled head of the screw *d*.

Fig. 4.



The imbedding mass employed by Dr. Roy is the well-known mixture of white wax and olive oil (equal parts by weight for warm, with a larger proportion of oil for cold weather) used with small oblong moulds of zinc without bottoms (instead of the usual paper boxes). They have the convenience of giving a cast suited to the size of the plate on which it is to rest. If the specimen is not imbedded, a pallet of wax or of wax and oil is placed between the tissue and the cork plate so that the edge of the razor may not come in contact with the latter.

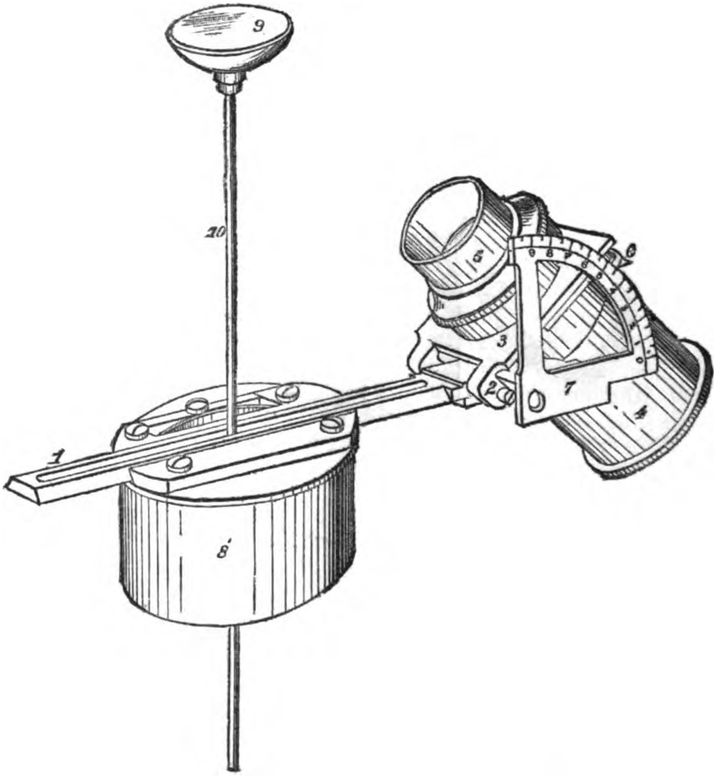
Woodward's Oblique Illuminator.*—Colonel Woodward has devised an apparatus, to which he gives the above name, intended to

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 268.

obtain with certainty illumination at definite angles with Microscope stands which are not fitted with a swinging substage. The inventor describes it as follows:—

"A perspective view of the apparatus (slightly reduced in size) is shown in Fig. 5. It consists of a transverse bar of brass (1), at one end of which, attached by a hinge (2), is a square brass plate (3), which can be inclined at any desired angle. This plate is transfixed

Fig. 5.



centrally by a brass tube half an inch long, in which a second tube (4) an inch and a half long slips easily. The slip-tube (4) is provided at one end with the Society's screw, by which a 3-inch objective (5) or any other preferred for the purpose, can be attached. The movable square plate is provided with a spring catch (6) which fits into any one of a series of notches in the edge of a brass quadrant (7), and thus serves both to hold the plate in position and to register the angle of obliquity. The transverse bar (1) slips in a groove on the upper surface of a strong brass tube (8), fitted to the substage of the Microscope. The bar itself has a longitudinal slot running nearly its whole

length, so that it can be pushed to any desired position without disturbing the position of the central steel rod (10), at the upper end of which a lens (9) is fastened. The lens (9) is such a segment of a hemisphere of crown glass, that when brought into optical contact (by oil of cloves) with the under surface of an ordinary glass object-slip, the object to be studied will be as nearly as possible at its centre of curvature, and the rod (10) slips freely in the top of the substage tube (8), so that the lens may be pushed into position or withdrawn at pleasure.

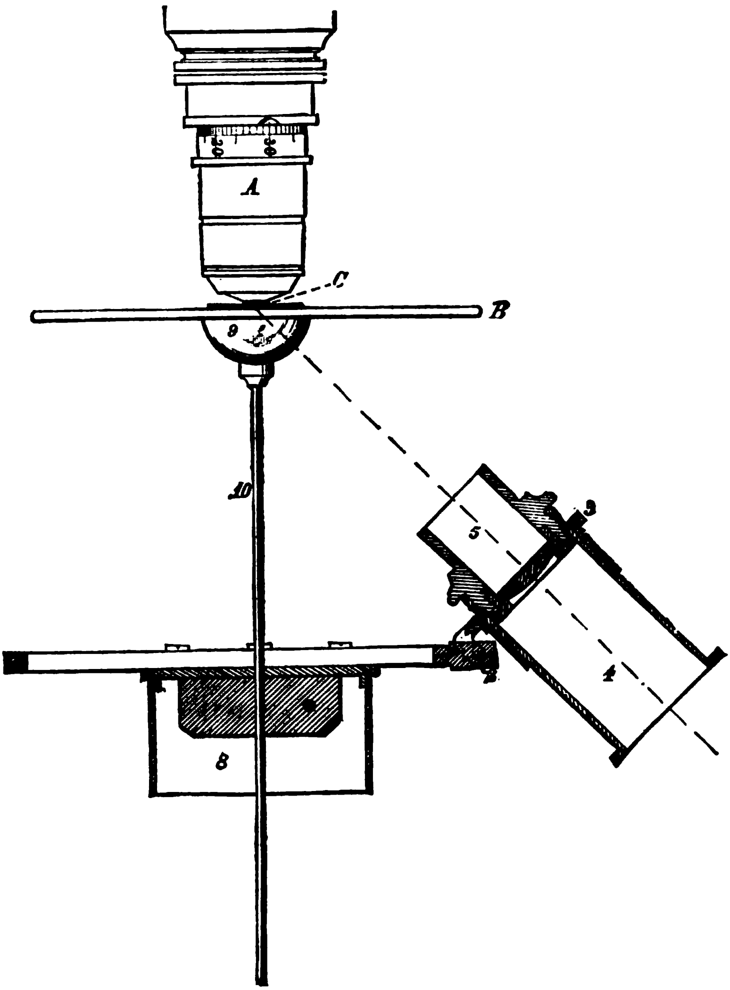
In using this apparatus with monochromatic sunlight, I first set the square brass plate)3) at the desired angle as read on the quadrant, and then slip the transverse bar (1) backwards or forwards as may be necessary, until the pencil of monochromatic sunlight (to which the desired degree of obliquity has been previously given by means of a prism) falls centrally through the slip-tube (4) and illuminating objective (5) upon the face of the lens with which the object is viewed. By means of the slip-tube, the illuminating objective (5) is then brought to the proper focal position. Ordinary illumination is thus obtained of any desired obliquity, from about 30° to the limit of the thickness of the stage. When I desire still greater obliquity I use Powell and Lealand's extra stage, and slip the transverse bar into the groove at the upper end of the holder which those makers provide with it to carry the small bull's-eyes they furnish for the examination of *Amphipleura pellucida.* In this manner I can get more oblique illumination up to 80° or even 85°, but of course the oblique pencils thus obtained are refracted at the under surface of the glass slip that carries the object, and cannot possibly reach the object itself at an obliquity greater than 41°. To obtain greater obliquity than this, I make use of the hemispherical lens (9). The illuminating objective is set at the desired angle, say 45°, and the object illuminated as described above. When this is satisfactorily done a drop of oil of cloves is placed on the flat surface of the hemispherical lens, which is then pushed up into contact with the under surface of the slide on which the object is mounted. The light now enters in the line of a radius of the hemisphere, at the angle registered on the quadrant (7). Fig. 6 represents a section of the apparatus when thus in use (also slightly reduced in size). The numbers in the two figures correspond. In addition, on Fig. 6, A is the objective, B the slide carrying the object, and C the immersion fluid.

I have found this apparatus exceedingly convenient for the purposes of photo-micrography and sunlight work generally; for when I have once obtained any particular result by means of a certain obliquity, I am able to reproduce the effect at pleasure without any loss of time. It has also proved useful, for the same reason, by ordinary lamplight. When, however, the object of the microscopist is merely to resolve *Amphipleura pellucida* or similar tests mounted in balsam, by lamplight, with suitable objectives, I still give preference to the simple substage prism I described last year,* through which I can throw the light at once at an angle of 45° by means of the concave

* See this Journal (1878), p. 246.

mirror or a small bull's-eye, and thus obtain for this particular purpose equally good effects, with less expenditure of time in making the adjustments."

FIG. 6.



Improvements in Microphotography.*—Dr. E. Cutler describes the apparatus he adopted for photographing with Tolles' $\frac{1}{75}$ objective, the special features in which the apparatus differs from Colonel Woodward's plan (besides portability) being (1) in the size of the

* 'Am. Journ. Sci. and Arts,' xviii. (1879) p. 93.

condenser, and (2) the absence of the ammonio-sulphate of copper or alum cells, which are troublesome.

The condenser consists of an 18-inch Voigtlander photographic objective, about 3 inches in diameter, and is probably the largest ever employed in microphotography. The reason of its selection was simply to avoid heat. It is easy to see that if a 2-inch condenser is regarded as sufficient, the same amount of light could be obtained with a 3-inch, away from the heat focus and thus avoid the effect of focussing the sun's rays on the object and the objective. This practical point has been of great value, and explains the absence of contrivances to prevent the passage of destructive heat.

Modern Applications of the Microscope to Geology.*—An interesting article on this subject is contributed by M. L. Fouqué to the 'Revue des Deux Mondes.' The progress of human knowledge, he says, is not accomplished in a regular and continuous manner, but by starts. Sometimes a man of genius gives a new impulse to science by the power of the divine reflex which animates him, but more often, particularly in experimental researches, each clearly marked impulse of the scientific movement is signalized by the employment of a new method of investigation. Thus the invention of the Microscope was the point of departure of brilliant discoveries in natural history, and each of its improvements corresponded to a period of progress in the development of the science to which it was applied. To-day the manufacture of the instrument has arrived at a remarkable degree of perfection, its magnifying power is enormous, its images are of an extreme clearness, and ingenious arrangements have rendered the instrument more manageable without having lessened precision, and its constructors have known how to adapt it to the special requirements of each class of research.

The consequences of these innovations were soon manifest. The study of organized beings took an unexpected turn, anatomy and vegetable physiology were entirely transformed, the domain of the zoological sciences was enlarged beyond conception, and the secrets of life have been explored in their most mysterious functions.

The application of the Microscope to the examination of the inorganic world took place more tardily in consequence of special obstacles. These difficulties are now happily surmounted. A harvest of new results is being reaped, so rich that it dazzles the imagination of those who gather it.

In the first part of the article is traced the historical development of modern "Microscopical Petrology," commencing with 1858, when Dr. Sorby's memorable researches first appeared, and on whom is passed a warm eulogium as "the real initiator and propagator of the new method," and after dealing with the labours of Zirkel, Vogelsang, and Rosenbusch the author regrets as a "curious matter and one difficult to explain that though in Germany microscopical petrography is now studied with unequalled ardour, in England, the country of its origin, it seems to make but slow progress."

* 'Revue des Deux Mondes,' xxxiv. (1879) pp. 406–31.

The second part explains the results obtained by the application of the Microscope to the study of minerals and rocks, and particularly the light thereby thrown on the actual constitution of the latter, and on the complex structure of a great number of crystals supposed to be simple, their mode of formation and the changes in the temperature, chemical composition, and stability of the media during the process. The Microscope is thus able to give an account of the conditions which prevailed when the minerals were being formed, as well as doubling the field to which geology can extend its conquests.

The third part gives a summary account of the methods of examination by polarized light, and the modern improvements which have been made in the examination of minerals by its means.

Adams' Measuring Polariscope.—This consists of three principal parts. The lower section consists of a mirror, a lens, a Nicol's prism, and two other lenses. The upper section consists of lenses and Nicol's prism arranged in the reverse order. Each lens and Nicol's prism is supported separately by screws, and its position can be altered independently of the others. These two parts form a complete polariscope.

Besides these there is a middle piece, consisting of two lenses (nearly hemispheres) forming a box to enclose the crystal immersed in oil, their curved surfaces being concentric. The whole middle piece is supported on the tubes of the upper and lower portions, and may be turned about the optical axis of the instrument. The vertical graduated circle carrying the central lens and crystal may be turned through an angle about its horizontal axis. By means of an arc fastened perpendicularly on the graduated circle, with its centre at the centre of curvature of the central lenses, the crystal may be turned about another horizontal axis at right angles to the former, so that the crystals and the central lenses can be turned about each by three axes which are mutually at right angles. By means of a system of toothed wheels in gear with the rims of the central lenses, the central and crystal lenses may be turned separately about the optical axis of the instrument, so as to bring the planes of the optic axes of a biaxial crystal parallel to the plane of the vertical graduated circle.

Homogeneous Immersion.—From conversations which we had with microscopists at the time of Professor Abbe's recent visit, it appears that the difference between the modern "Homogeneous Immersion" and the "Oil-Immersion" of Amici and Hartnack has not been appreciated.

One of the leading points of Professor Abbe's theory of 1874 was his explanation of the important bearing which the *diffraction pencils* have on the formation of the microscopic image so that the resolving power of an object-glass is dependent upon the diffraction pencils that are taken up by it.

This fact was not previously known, and in the absence of that knowledge it is not surprising that those who suggested the use of oil instead of water abandoned it in practice, not thinking it worth while

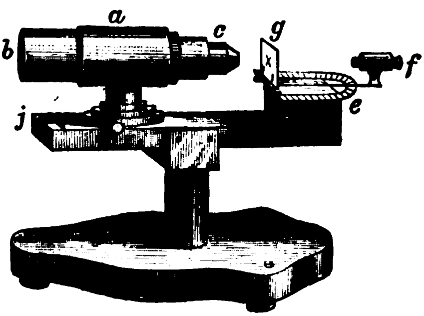
to follow it up. The use of oil as an immersion fluid would obviously have seemed at that time to be a *disadvantage* so far as aperture was concerned, in consequence of the diminution of *angle* which was necessarily caused.

When, however, the bearing of Professor Abbe's theory was appreciated, it was seen that an object-glass acting in oil might take up diffraction pencils which one of larger angle acting in air could not reach, and hence, although the *angle* was reduced by the use of oil, yet the diffraction pencils belonging to an *aperture* of more than 180° in air would be compressed (so to say) within the lesser angle, and greatly increased *apertures* could be utilized.

"Homogeneous immersion" is thus seen to be essentially dependent upon the principles enunciated by Professor Abbe in 1874, and the reason why it was not previously discovered, even by those whose minds were directed to the subject, is explained.*

Hamilton Smith's "Universal Apertometer."†—Prof. Hamilton L. Smith describes this apparatus devised by him (Fig. 7), which he uses for measuring the true angle in all cases, the old system being, he considers, all wrong, telling a false story in either case, dry or immersion. For angles in glass, or for immersions, the new apparatus may be used precisely like Dr. Abbe's apertometer, and indeed, as it seems to him, has some advantages over that instrument, which will not give the direct air angle, but deduces it from the angle

FIG. 7.



in glass; a separate graduation being required when it is to be read off directly. The 180° are compressed into an arc of 82°, and the whole space on that arc between 60° and 80° is not more than that between 0° and 10°, i. e. the graduations are necessarily unequal, and the instrument is only graduated to every fifth degree. The cylindrical surface, though it may show a sliding edge with sufficient clearness, is not so good as the more easily made spherical surface

* Mr. Stephenson draws our attention to an error in his note on p. 490, in which he says that the present homogeneous system "gives an *angle* greatly in excess of even the ideal maximum of a dry lens (180°)"—for "*angle*" should be read "*aperture*."

† 'Am. Quart. Micr. Journ.,' i. (1879) p. 194.

which forms a part of the new instrument, and by means of which one may bisect a minute white circle with the greatest accuracy. Moreover, few would be able to graduate the "apertometer" correctly, and the process of computation, though easy enough, is not necessary.

A brass tube *a* (Fig. 7), say 2 inches long, is supported on a pillar, into which another tube *b* slides easily, carrying at one end the objective *c*; the other end *b* is open except when a cap with a small hole is put on for purposes of centring, and when it is used after the manner of Abbe's apertometer; *e* is an arc (a good protractor answers very well) graduated to degrees (any higher refinement is quite useless, as in the larger angles there will always be an uncertainty of at least a quarter of a degree, a space readily estimated). An arm moving freely on a pin at the centre of the arc, carries at its end an eye-lens in a small sliding tube, and having a small eye-hole *f*, the lens having its focus over the central pin; *g* is an ordinary glass slide (3 by 1), which can be slipped in or out of place at will, and is held at right angles to the plane of the graduated arc by two springs, which press it against two uprights, so that the front surface of the glass is exactly over the centre of the arc, and therefore of the pin on which the movable arm turns. The glass slide is held by a separate brass holder, which can be pushed forward when the focal point of the objective is just over the pin until the slide touches the front lens, and a black bar with a straight edge painted on the glass can be made to cut off just half of the surface of the front lens, by putting in the perforated cap at *b*, and looking through *f*, which is supposed to be standing over the middle of the arc. This is for using Mr. Wenham's method, and it gives very nearly the same results as his (Prof. Smith's) own. The apparent aperture of the uncovered half is measured (twice this will give an extravagant angle), the whole aperture is then measured, but in the usual way, i. e. until the light disappears; the angle of the half is now subtracted from that of the whole, and twice the remainder is the true angle; this method is only available when the front lens is flush with the surface.

The mode in which he prefers to use the instrument, however, and which gives the true air angle, is as follows:—The front surface of the slide *g* is brought accurately over the centre of the arc by slipping the brass holder quite home; two fine cross lines ruled with a diamond on the glass, are, by sliding the glass laterally, brought directly over the centre of the arc or pin on which the arm carrying *f* moves; their intersection is thus placed directly over the centre of motion; the objective is focussed on these lines: it is not necessary to use an eye-piece unless the focal length be very long. Yet for true angle, independent of definite length of tube, it would be sufficient simply to focus upon the lines without an eye-piece; the screw *j* may be used for this purpose, or it may be effected by simply sliding the tube *b* in *a*. Suppose now the eye-lens *f* to be over the middle of the arc; on looking through towards the objective one will see something like Fig. 8, where the outer circle is the periphery of

the front lens, the middle one is the image of the diaphragm at the back of the objective; or, if this diaphragm is sufficiently large, the margin of the posterior system; the inner circle is the image of the end of the tube *b*, and within the area of this will be an inverted picture of external objects crossed at the centre by the lines on the glass; the objective *c* and the eye-lens *f* forming a sort of miniature telescope, and having the lines as a common focal point: the smaller circle would disappear if the end of the tube *b* was large enough, and there would be but these two—the periphery of the front lens, and the image of the diaphragm or posterior system—and it is with this last we are to deal. A piece of tissue paper, or cap with

Fig. 8.

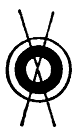


Fig. 9.

Fig. 10.

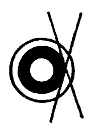


Fig. 11.

ground glass, is now put on at *b*, and immediately a soft light fills the field, and the lines appear like cobwebs stretching across it. The sector arm carrying the lens *f* is now swung round until the intersection of the lines is tangent to the image of the margin of the posterior system or diaphragm, as in Figs. 9 and 10, which represent the circles as they would appear with very small angles; with wide angles they are foreshortened as in Fig. 11, where the larger circle is,

Fig. 12.

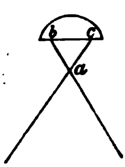
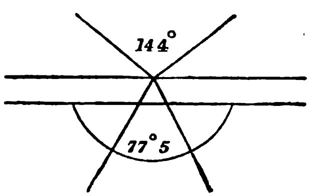


Fig. 13.

Fig. 14.



as before, the margin of the front lens; the next inner one is the image of the diaphragm, and the smaller (partly obscure) is the bright field still visible, and which gives the exaggerated angle to measurements made in the old way. The sector arm may be swung many degrees farther on each side before this will disappear. When the fine lines are thus projected on the face of the front lens, they will, as in Fig. 12, mark the extremities of a diameter of the circle which, if stopped out, would exclude all light from passing through

the objective when used to form an image in the field of the eye-piece of the Microscope.

So much for the air angle; for balsam, or what we will here consider as the same thing, angle in glass, the slide *g* is replaced by another (Fig. 13) of the same thickness, but with a small bull's-eye—say 0·25 inch radius—cemented to it, and of such thickness that its centre of curvature is in the front surface of the slide; fine lines are also ruled on this slide passing through the centre of curvature of the lens. When the bull's-eye is properly adjusted, it will make no difference in the distinctness with which the images of external objects are exhibited when using the objective and eye-lens *f* as a little telescope, whether the glass slide and bull's-eye are in position, or whether they are removed, the rays pass through the slide and bull's-eye, emerging without refraction at the convex surface; they will emerge indeed at a much smaller angle, as shown in Fig. 14, from the refraction at the front surface; and in this refraction nearly all the rays which give the exaggerated angle disappear, and the angle of the emergent rays is the true angle in glass, from which the true air angle may be computed. To avoid this computation, Zeiss constructs the apertometer with another scale, upon which an arc of 82° corresponds to 180°, and one of 77·5° to 144°, &c.

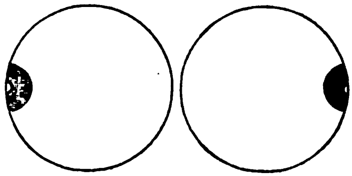
A Spencer $\frac{1}{8}$ inch, when the systems were closed, and it was adjusted on the cross lines in the centre of curvature of the hemispherical lens, transmitted rays making an angle of 77·5°. The natural sine of half this angle is ·6259, and this, multiplied by 1·52, assumed as the index of refraction of glass, gives ·9513, the natural sine of 72·05°, twice which, or 144·1°, is the air angle. Measured directly, using the glass slide *g*, and the lines as before described, 144° was obtained. Measured on the sector in the old way, there was no difficulty in getting 179° before the light disappeared.

It will be understood that for immersion angle, or, as it is generally called, "balsam angle," all that is necessary is to introduce a drop of fluid (theoretically, this should have the same refractive index as the glass) between the objective front and the glass slide, and to re-focus on the lines. The $\frac{1}{8}$ inch, at the same closed point which gave only 77·5° from air into glass, will give 87° with glycerine interposed. There is very little difficulty in observing the true angle here; the proper point is when the circle of light, which is beautifully shown when the tissue paper covers the open end of the tube *b*, is dichotomized, and the slightest movement will cause it to disappear. This action is even more prompt with the fluid interposed than when air intervenes.

To convert the instrument substantially into Abbe's apertometer, it is only necessary to keep the slide and the bull's eye in place, focus on the lines, and then, putting on the cap with the small eye-hole at *b*, look in there instead of at *f*. Placing a sheet of paper in front of the graduated sector, and allowing the light to shine through it, we shall get a distinct picture of the end of the tube *f*, and see a little spot of light (the eye-hole) in the centre. The lines ruled on the glass may interfere with perfect definition in the middle of the field,

but when the sector arm is swung round, the little circle of light can be neatly bisected on each side of the field, as shown in Figs. 15 and 16. A long focus lens may be applied at the eye-hole if necessary, or the supplemental tube recommended for Abbe's apertometer, but the Professor finds all that is required is his ordinary reading-glasses, and he can make the bisection of the little bright circle as accurately as when using a compound Microscope to view it even with a $\frac{1}{12}$ objective.

FIG. 15. FIG. 16.



If we remove the bull's-eye slide, and focus on the lines on the plain slide, we may obtain the air angle with great accuracy by simply looking through the eye-hole in the cap applied at the end of the tube *b* (Fig. 7), and observing, by aid of a long focus lens, when the image of the hole in *f* is neatly bisected on either side, as shown in Figs. 15 and 16. If, instead of a single lens, a short compound Microscope with an objective of 4 inches focus is used, the eye-hole will not be necessary. Except for higher amplification, this supplemental part is not needed. The highest air angle objective measured by Professor Smith is an old $\frac{1}{18}$ by Spencer, 163°. He has no doubt that some of the first-class modern dry objectives of recent date may reach 170° or more; but even with an angle of 163° the extreme rays strike with such obliquity, that more than half the light is reflected from the front surface, without entering the lens at all, and yet more at higher obliquities. Professor Smith does not mean to say that there is not a gain worth striving for in passing from, say, 160° to 170°, but an objective whose real air angle is more than that last named will have an inconveniently short working distance.

To compute rigidly the balsam or glass angle from the observed air angle, or *vice versâ*, the objective must not only be accurately focussed, but the intersecting lines *must* be used; otherwise an exaggerated angle (varying very much in different objectives, to the extent of 2° to 12°) may be obtained as the glass angle; and if from this we should compute the air angle, it might be 10° or 20° too much.

Carefully used, the instrument will give entirely concordant results. Moving to the right, the point of intersection will travel in the same direction as from Fig. 8 to Fig. 10, and to the left the change will be from Fig. 8 to Fig. 9. This is contrary to what one might at first suppose; a little reflection will show the reason for this.

As it seems to have been supposed that Professor Smith intended in his paper to cast doubts on the accuracy of Professor Abbe's instrument, we may point that the Professor himself says in his

original article that "with high powers and wide angles, *the agreement between his own instrument and that of Professor Abbe is as close as could be desired*," while Colonel Woodward shows * the source of the erroneous readings which Professor Smith obtained when he attempted to use his apparatus after the Abbe method with low-power objectives.

Mr. Wenham, writing on this paper,† calls attention to the following experiments, not as indicating any defect in Professor Smith's principle, but in the mode of use which he considers may be the cause of error in the measurement:—

In order to well define the transmitting diameter or boundary of the light spot on the front of the glass, Professor Smith applies a piece of tissue paper or ground glass to the open end of the object-glass tube. This gives results in excess of truth, which may be attributed to the diameter of the screen. Instead of following this course, set a lamp a few feet away exactly in the axis of the object-glass, and focus the Microscope on the index line; the flame of the lamp will be beautifully in focus at the same time, showing that the examining Microscope does not in the least alter the focal distance of the object-glass under test. On traversing the lower Microscope sideways, the flame appears curiously projected, as if it were actually strung on to the lines ruled on the glass. At an obliquity greater or less according to the aperture of the objective, the flame shows a tendency to leave the line before it vanishes. Now, with the flame, this limit gives a result less than when the ground glass is used. The former is, therefore, the limit of aperture. The ground glass does not increase the transmitting diameter of the front, which remains the same under all circumstances; but it allows oblique rays from a screen or field of view to pass through. The lamp flame is distant, and in one fixed, axial, focal point. As the image of the flame and the ruled line are kept in the direction of the axis of the examining Microscope, the angular traverse of the line of this axis must indicate the true aperture.

Mr. Wenham also thus summarizes the facts upon which Professor Smith's conclusions are based:—

"1. That the front lenses of Microscope object-glasses only admit incident rays through a central area, far within their actual diameter.

"2. That angle of aperture strictly means the angle measured by a triangle taken from the extremities of the diameter of this light spot as a base line up to the focal distance in the axis, whether that distance is in air, water, or glass, with the difference of angle due to the refraction of each.

"3. That rays extending laterally from places without the central focal point do not constitute a proper angle of aperture, but cover an area known as field of view.

"4. That rays from every part of the field of view pass through every portion of the transmitting diameter of the front lens, and, together, enter the pupil of the eye from the eye-piece.

"5. That in the optical methods of measuring angles of aperture

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 278. See infra, p. 784.

† Ibid., p. 280.

heretofore in use, rays from the light or index points have traversed and intersected all these exterior rays or oblique angles in succession to the limit of the field of view, which has been erroneously assigned as angle of aperture."

Measuring Aperture.—Professor Hamilton Smith in his paper above referred to describes an experiment with a Spencer $\frac{1}{8}$, made when the systems were closed and a small dot of ink put on the flat surface of the front lens, just large enough to cut off the little circle of light that appears when one looks into the objective with the front system toward the eye. Under these circumstances when the objective was attached to the Microscope, not a ray of light could be obtained except what came through the instrument, yet on the sector he was still able to see light when the arm was swung up to 179°. He further says, "The true air angle at the same closed point . . . . is only 144°."

Mr. J. Mayall, jun., properly points out * that this experiment is fallacious. "It being admitted that no aperture, properly speaking, can be measured unless the image of a point be rendered, approximately at least, as a point; does Professor Smith mean to say that when the system of lenses is closed he can measure the true air angle? My experience with immersion lenses of high angle is that when the system is closed, so as to get definition through the thickest cover-glass and the immersion medium, at that adjustment no true air angle can be obtained. The true air angle can only be actually measured when the objective is adjusted so as to give true focus in air, a focus sensibly free from aberration."

So far as Professor Smith's apertometer is applicable to immersion lenses, Mr. Mayall considers it is practically the same as Mr. Tolles's traverse lens which yields results equivalent to those obtained with Abbe's apertometer.

Woodward's Apertometer.†—Colonel Woodward describes an apertometer which he has been using for some time, which is a combination of the Abbe apertometer with the well-known sector, and which he thinks has advantages over both that and the Universal apertometer of Professor Smith.

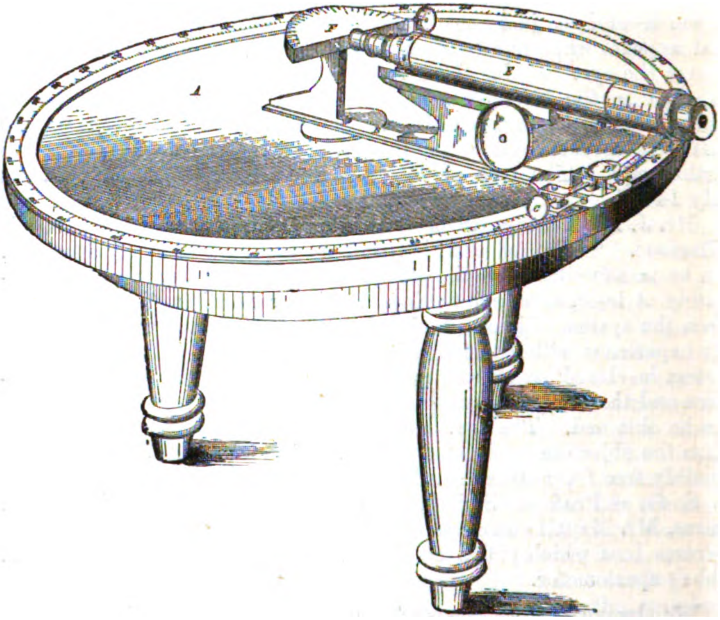
Colonel Woodward objects to the Abbe apertometer (1) in regard to the cutting away of the surface that corresponds to the diameter of the semicylinder at an angle of 45°, rendering necessary the silvered cover-glass with circular central spot, which should correspond to a path of the rays to the oblique surface, and thence by reflection upwards, just equal to the radius of curvature, an error in selecting this point rendering the reading inaccurate; and (2) in regard to the graduation into divisions corresponding to an arbitrary scale. The modified instrument is shown in Fig. 17.

A is a circular disk of brass of about 10 inches radius, inlaid near its circumference with a silver circle divided to sixths of a degree. It is mounted for convenience on a heavy three-legged stool of wood.

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 284.
† Ibid., p. 272.

It was made a full circle, in order to use it for another purpose also; but a semicircle of the same size would answer equally well. Into a hole in the centre a pin is fitted, on which swings the radial arm B, which carries on one side of the centre of rotation the body of a Microscope E, while its extremity is provided with a vernier clamp D and

FIG. 17.



tangent screw C. On the other side of the central pin the radial arm carries a table, on which is mounted a semicircle of crown glass F of about two inches radius and half an inch thick. This is so mounted that the edge, which corresponds to the diameter of the semicircle, is directly over the centre of rotation, and the Microscope objective can be focussed exactly upon the centre of the semicircle. At this spot a thin glass cover, silvered except at a central circular hole (or vertical slit) about $\frac{1}{20}$ of an inch in diameter, is cemented with Canada balsam, the central hole (or slit) being fitted precisely over the centre of the semicircle. A suitable achromatic convex lens (a 4-inch objective answers very well) is screwed at the end of the draw-tube of the Microscope body, and serves to convert it into a telescope, precisely as in the apparatus of Abbe.*

The particular method for which the apparatus was constructed and by which exact measurements can be made, is as follows. Using

* This apparatus can be used precisely like his, if the semicircle is engraved to degrees, and two shutters or indices provided.

the Microscope as a telescope, some distant object is viewed so small that it only occupies an extremely minute portion of the field, and so bright that it can easily be discerned as the slit of a spectroscope placed at about 10 feet and illuminated by monochromatic (blue) sunlight. This appears when the adjustments are rightly made as an extremely minute blue star in the centre of the field. The radial arm is then swung until the star comes to the extreme margin of the field, the adjustment is made as exact as possible with the tangent screw, and the vernier read. The radial arm is then swung till the star comes to the opposite margin of the field where the same process is repeated. The difference between the two readings is the aperture of the objective for any medium of the same index of refraction as the crown glass semicircle. The apparatus reads to half minutes, which is closer than the observations can be accurately made. In fact, after the star comes to the edge of the field, it usually begins to fade just before it entirely disappears, and a motion of several minutes is necessary to effect the change. The best plan is to adjust the instrument as exactly as possible at the point at which the star begins to fade and then read to the next lowest sixth of a degree, neglecting the small fractional remainder. The same instrument answers very well to measure the glass angle corresponding to the actual air angle of dry objectives of any power, or the semicircle of glass being removed and the Microscope still used as a telescope to view the blue illuminated slit as before, air angles may be directly read with a degree of precision not attainable when the sector is used in the ordinary way.

From the angles of aperture measured in the semicircle of crown glass, it is quite as easy to compute air angles, water angles, glycerine angles, balsam angles, &c., as from the numerical scale of Abbe. It is only necessary to subtract the logarithm of the index of refraction of the rarer medium in which the aperture is to be expressed from that of the index of the glass semicircle, and to preserve the difference as a constant for use whenever the aperture in the selected medium is to be computed from the angle observed with the semicircle. Then to perform the computation, it will only be necessary to add this constant to the logarithmic sine of half the observed angle, and take from the table of logarithmic sines the angle corresponding to the sum, which will be half the angle required.

It will readily be understood that if the crown glass semicircle of the apparatus is of precisely the same index of refraction as the crown glass front of the objective, the rays of light passing into the objective from the semicircle will, after more or less refraction as they enter and leave the immersion fluid, resume in the crown glass front, precisely the same course they had in the semicircle. In this case the angle measured in the semicircle would be precisely equal to the aperture of the pencil passing through the crown glass front, and might be called the *first interior angle of aperture*, or briefly, the *interior aperture* of the objective. As this is the angle which after all determines the resolving power of the objective (provided its aberrations are properly corrected), Colonel Woodward thinks it would be better

hereafter to express the angle of objectives in degrees of interior aperture instead of speaking of air, water, or balsam angles, or using the numerical scale of Abbe. This end will be obtained with sufficient exactness if the crown glass semicircle has an index of refraction of 1·525. In this case the angles read by the apparatus with each objective will be its interior aperture, and no computation will be necessary. But equally exact results can be obtained from a glass semicircle of higher or lower index, provided only its index of refraction is known. In this case it is simply necessary to compute the corresponding angle in a medium of 1·525 from the observed angle by the method already explained.

The index of refraction of the glass semicircle may be exactly determined in the ordinary way by measuring the angular deviation produced by a prism cut from the same piece of glass. But in the absence of conveniences for this determination it is one of the advantages of this apertometer that it affords the means of measuring the index of the glass semicircle with sufficient accuracy, for if the angle of any immersion objective that exceeds 90° of interior aperture be measured by it, and then the immersion fluid wiped away, and the angle measured with a very thin film of air between the front of the objective and the semicircle, the observed angle will be reduced to a figure which is constant for all objectives of the same or greater aperture, and which is independent of variations in the angles of such objectives, representing in fact double the angle of total reflection from the glass of the semicircle to air. If the sine of half this constant angle be divided into unity the quotient will be of course the index of refraction of the glass semicircle.

Provided the glass semicircle is nicely centred, the silvering of the glass cover which prevents vision from taking place except through the small hole or slit directly over the centre of the semicircle, would be unnecessary with the highest powers; for the diameter of the circular spot through which rays can pass into the objective is so small, as compared with the diameter of the semicircle, that the greatest possible chance of error from this source will be very small indeed. But with dry lenses of low power this is not the case; the greater the transverse diameter of the objective, the more readily would those rays enter it, which having passed through the semicircle but not through its centre, would indicate a greater aperture than the objective actually possessed. This is, Colonel Woodward supposes, the source of the erroneous readings which Professor Smith obtained* when he attempted to use his apparatus after the method of Abbe with low-power objectives. He did not use the opaque cover with a small central hole which is indispensable in this case.

Microscopical Researches in High-power Definition.†—Dr. G. W. Royston-Pigott presented a paper on this subject to the Royal Society in their last session (not yet printed *in extenso*), but of which the following is an abstract by the author.

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 203.
† 'Proc. Roy. Soc.,' xxix. (1879) p. 164.

In its general scope the paper is intended to deal with difficulties in microscopic research, usually found insuperable, such, for instance, as the invisibility of minute *closely packed* refracting spherules, existing in double rouleaux, or promiscuously aggregated; when their individual diameter varies between the $\frac{1}{80000}$ to the $\frac{1}{200000}$ of an inch.

These difficulties are principally created by overlapping images, due partly to residuary aberration both spherical and chromatic, partly to the effects of diffraction, caused by brilliant illuminations of spurious disks of light, partly to the constant development of Eidola or false images, which vary the loci of their development according to the nature of underlying structures, and according to the object-glasses being over- or under-corrected, and partly, and indeed very considerably, created by the use of excessively large angular apertures.

The paper discusses also the relative effects on visibility, of large and small angular apertures in objectives.

It shows that the black margins or black marginal annuli of refracting spherules, constantly displayed by low aperture glasses, are attenuated gradually to invisibility, as the glasses employed are endowed with the largest apertures; that the black margins also of cylinders, tubules, or semi-tubules suffer similar obliterations; and that, in consequence, innumerable minute details are concealed or destroyed till the aperture is sufficiently reduced; that minute refracting bodies obey the laws of their refrangibilities, and display beautiful phenomena, discoverable by transcendent powers of definition, but totally unseen by inferior compensations; and that, in consequence, the so-called achromatism of modern glasses is an illusory approximation to correct vision.

Examples are given of molecular structures, varying in form, translucency, and refrangibility, in which natural pencils are caught and displayed in the order in which, as in a rain-drop, iridescent rays are emitted by the decomposed light. Several examples are also introduced, in which a high order of lenticular correction beautifully discovers structure, hidden, according to Dr. Carpenter, from the great bulk of observers.

As the paper deals so often with magnitudes very much less than the $\frac{1}{100000}$ of an inch, a method is introduced of readily estimating roughly such magnitudes between the $\frac{1}{80000}$ and the $\frac{1}{500000}$ of an inch, by means of a micrometer gauge. The writer has been emboldened to grapple with these difficult minutiæ, in consequence of the sharp and clear definition he has attained of spider lines miniatured down to the fourteenth part of $\frac{1}{100000}$ of an inch. The eye, accustomed to contemplate this subtlety of form, readily appreciates the one-fourth or one-sixth of this size, i. e. $\frac{1}{400000}$ or $\frac{1}{600000}$.

A new test for the Microscope is also described displaying bright lines of uniform thickness less than $\frac{1}{100000}$, and sharp black lines of much less tenuity than those given by Nobert's celebrated lines ruled on glass, and incomparably more easy of illustration.

The employment of various fluids for immersion lenses is care-

fully considered; and the singular property of castor oil, discovered by the writer, is referred to.

As the author's paper on "A Searcher for Aplanatic Images," was inserted in the 'Transactions,' he now introduces a new form which offers some advantages, by its extended traverse, by its simplicity and economy of light with increase of magnifying power.

Finally, some examples are given of producing transcendent definition in cases found hopeless by a numerous body of observers. The means also of its attainment are minutely described.

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TRANSACTIONS OF THE SOCIETY.

XXXV.—*On the Morphology of Vegetable Tissues.*

By W. H. Gilburt, F.R.M.S.

(*Read 8th October*, 1879.)

(Plates XXII. and XXIII.)

In the early autumn of last year, while examining some preparations I had been making of the leaf-buds of various trees, certain appearances were observed, which seemed scarcely to agree with the views now held, concerning the origin of the cambium layer in the stems of the woody dicotyledons; and suggested the desirability of a further study of the subject.

During the twelvemonth which has since elapsed I have followed up the inquiry, with results of at least considerable interest.

EXPLANATION OF PLATES XXII. AND XXIII.

All figures drawn with Camera Lucida.

pcb, procambium; *cb*, cambium; *mr*, medullary rays; *m*, medulla; *c*, cortex; *sv*, spiral vessel; *ss*, sieve septa; *rv*, rudimentary vessels.

Figs. 1, 2.—Sections through procambium of *Cytisus laburnum*, showing earliest observed appearance of cambium. Fig. 1. Very oblique, radial diameter of cells much exaggerated.

Figs. 3–5.—Sections through procambium of Lombardy poplar. Fig. 3. Showing first division of procambium cells. Figs. 4, 5. Two stages in development of cambium.

Figs. 6–8.—Sections of *Ficus carica*. Fig. 6. Before division of generating cells on xylem side. Fig. 7. Enlargement, division, and thickening of cells, producing first vessels of medullary sheath. Fig 8. Appearance of cambium septa in cells dividing thickened cell-forms.

Figs. 9–11.—Tangential sections through cambium of *Cytisus laburnum*.

Figs. 12, 13.— ,, ,, *Syringa vulgaris*. (Figs. 9, 10, 12, 13. Showing cambium cell-groups. Fig. 11. Same after absorption of transverse septa. Medullary rays in transverse section.)

Fig. 14.—Section through cambium of *Salisburia adiantifolia*.

Fig. 15.—Development of vessels in *Sambucus nigra*; sieve septa indicated by dotted lines; transverse septa still remaining.

Fig. 16.—Sieve septa in rudimentary vessels of *Ailanthus glandulosus*; very oblique, and cut through.

The doctrine generally held concerning the origin of the cambium may be briefly stated as follows:—

That after the development from the primary meristem of the primary cortex and pith, a zone remains between them, which preserves its merismatic character, and is called the procambium; the cells of which are similar to each other, and are combined without intercellular spaces; that on either side of this procambium the cells are differentiated into permanent tissue, on the outer side bast and parenchyma, on the inner side prosenchyma and vessels; and that in open bundles a certain portion remains over between these two tissue systems; this portion constituting the cambium layer.

Now in the sections through the apices of the stems and terminal buds of certain trees referred to above, I observed that on the inner side of the procambium ring or bundles, there were a greater or less number of cells which appeared in every respect to agree with those which in older stems separate the xylem from the phlœm; being thin-walled, regular in disposition, without intercellular spaces, and arranged radially with regard to the axis of the stem. Examining a section somewhat farther from the apex, I found that a few of the cells adjoining the pith were thickened; while in a section nearer to the apex, the procambium zone was thinner, and the cambium-like series absent.

The thought naturally suggested by these observations was, that possibly the cambium was not in itself a portion of the procambium, but a special tissue developed from it. In order to determine this, I have made many preparations of the terminal buds of some sixteen species, but owing to the sharply curved course taken by the procambium at or near the apex, and consequently the line of section being at a more or less acute angle with its length, the inquiry proved one of considerable difficulty. Nevertheless, in all cases at a suitable distance from the apex, this cambium-like tissue was to be found either with or without one or two thickened cells on its inner surface, while the remainder of the procambium was undergoing differentiation into hard and soft bast.

A few species, however, were most instructive, especially the Laburnum (*Cytisus laburnum*), Lombardy poplar (*Populus nigra*), and the Fig (*Ficus carica*); and after a careful and prolonged study of them, there seems but one conclusion possible; viz. that the whole of the procambium is differentiated into hard and soft bast, with the exception of its innermost layer, the cells of which by means of successive tangential divisions, produce a cambium tissue; this new generating tissue preceding in order of development the appearance of any thickened cell-forms on the xylem side.

In its earliest condition the procambium can only be distinguished from the surrounding tissue, when examined in transverse section, by the comparatively small size of the cells composing it. This similarity, however, speedily disappears, as most of its cells divide into two, three, or four; the cell-plates being laid down indifferently as to order or relative position. This is well shown in Fig. 3, which represents a portion of the procambium of the Lombardy poplar. This division of the cells does not take place simultaneously throughout the whole of the tissue, but commences at certain spots which correspond with the position to be occupied by the vascular bundles, whether primary, secondary, or of a higher order.

In some species the next step in development consists in certain cells at more or less definite distances, growing most rapidly, and dividing in a radial direction, that is, with regard to the axis of the stem; this being the commencement of the primary medullary rays. In others, however, these are not to be distinguished till much later.

In Figs. 6 and 7, which are from a section of *Ficus carica*, the primary medullary rays are present, and it will be seen that by them the procambium is separated into well-marked bundles, and while on their inner side there is no distinct line separating them from the medulla, yet that on the outside their limits are well defined.

The next stage is, that the layer of procambium-cells next the medulla, which have remained unaltered, and which I would call the generating layer, becomes divided by septa which are invariably tangential to the circumference of the stem. As the differentiation of the phlœm elements commenced at certain points which agree with the position and order of the future vascular bundles, so with the septation of these cells; commencing at certain definite points the process continues till we have a closed cambium ring or a series of bundles separated from each other by the primary medullary rays. In Fig. 1, which represents a portion of the procambium of the laburnum, it will be seen that there are three cells, which show this septation at the earliest stage in which I have observed it. In each cell there are two septa, the outermost one of which is the thinnest, and therefore the last laid down. In Fig. 2 is shown part of a bundle from the same section, of rather earlier origin, in which we have a radial series of four or five cambium-cells; the fact of their origin being from a single cell is still plainly indicated by the greater thickness of the mother-cell wall which still seems to surround them.

The same process in every important particular holds good in the Lombardy poplar, three stages in the development of which are represented in Figs. 3–5. I have, however, occasionally

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found on the inner side of the cambium in this species, a few cells of small calibre, which do not appear to have been developed from it; although I have not been able to trace their origin with certainty, the probability being that they result from the division of the outer cells of the medulla. These cells may remain permanently thin-walled, or some of them may become thickened—a differentiation, however, which is not observed until the cambium is some three or four cells in thickness.

With regard to the order of development of the cells forming the cambium, it was just stated that in the earliest stage observed in the laburnum, there were two tangential septa thrown across the mother-cell, and that the one nearest the phlœm being the thinnest, was the youngest. In the consideration of this part of the question we are greatly helped by a study of what takes place in *Ficus carica*. In this species the process of development is somewhat modified, as a reference to the figures will at once render apparent. Fig. 6 is a section through the procambium immediately after its differentiation into phlœm elements, and no indication of either xylem or cambium is seen. In Fig. 7 at *a* we find a cell adjoining the medulla, which has enlarged and divided tangentially into two daughter-cells. At *b*, *b* we notice that in two cells in which this same process commenced earlier the daughter-cell next the pith has become spirally thickened, while its sister-cell has grown and divided again in the same direction. Growth in the two daughter-cells at first takes place equally, so that we find them both of one size; but there is this difference in them, that while one passes over into a permanent form, the other preserves its generating character; so that by the time the one has become fully developed the other is again ready for further division.

It will be observed that the cells we have just been dealing with are separated from each other by one or two cells of smaller dimensions. In these, growth takes place equally with those already described, but the divisions arise irregularly, sometimes being tangential, at others radial.

This order of development continues till the condition shown in Fig. 8 is reached. Here we have, proceeding from the centre of the stem, a series composed of two or three spiral cells or vessels preceded by two or three thin-walled cells, the whole of them being produced in regular succession by division of the cell immediately adjoining the phlœm. Thus far, then, development has taken place in regular progression, proceeding from the centre outward. At this stage we notice that tangential septa arise in the cells which separate these series of thickened cell-forms the one from the other, and thus a continuous band of cambium is produced in the bundle.

At first sight it would appear that in this species we have an

example which differs in most important particulars from the conclusion stated early in this paper. But it must be borne in mind that the development of these xylem elements commenced by the enlargement and division of a single cell, and not simply by the thickening of a cell already existing in the procambium, and that the tissue intervening between the several series of thickened cell-forms, is at first produced from the same layer of cells, viz. those immediately adjoining the pith. This statement is supported by the fact, that, although the bundle as a whole has increased greatly in radial diameter, yet the phlœm portion of it remains about the same as at first; the small amount of apparent growth resulting probably from the greater size of the individual cells, and not from their increased number. We must therefore regard the xylem elements and the cambium, the development of which we have been tracing, as new tissues resulting from the activity of the generating layer of cells, that in the other species produces the cambium at the first.

The progressive development of the cambium-cells described above appears to hold till the tissue consists of some six or eight cells in thickness, after which division takes place frequently in the cells which form its three or four outermost layers, as I have found thin cell plates between thicker ones, the cells thus cut off being about half the size of those immediately contiguous.

The species which I have studied, in addition to the three already referred to, are *Ribes nigrum*, *Æsculus hippocastanea*, *Betulus alba*, *Quercus robur*, *Quercus ilex*, *Acer pseudo-platanus*, *Fagus sylvatica*, *Ulmus campestris*, *Syringa vulgaris*, *Castanea* sp., *Nerium oleander;* and, while I have not been able in all cases to carry back the investigations to the earliest divisions of the generating cells, yet they all agree in this: the cambium tissue is always to be seen next the medulla before the appearance of any thickened cell-forms, and that the farther you can carry the inquiry back, the smaller is the number of cells of which the cambium is composed.

In one species only, viz. *Tilia europæa*, have I failed to see the cambium as just described, and that simply from the very sharply curved course taken by the vascular bundles at the apex, and the extreme difficulty of getting a section at all favourable for observation of the earliest stages of development. There is no doubt, however, judging from what I have seen, that it agrees closely with the other species examined.

Turning now to a consideration of the structure of the cambium-layer, I find that it differs in certain important particulars from what it is generally understood to be.

In studying this tissue, the plan followed has been to make a series of tangential sections of the region existing between the bast

fibres and the true wood, keeping each section separate and numbered in its proper order.

Now, the only statement made, concerning the structure of the cambium, is, that its cells are thin-walled, close-fitting, filled with protoplasm, and generally prosenchymatous in form.

In this part of my investigations, serial preparations of the following species have been made:—

Fraxinus excelsior	2, 3	Larix europæus	8–10
Prunus lusitanicus	4–6	Taxus baccata	6–8
Tilia europæa	4	Ficus carica	4
Syringa vulgaris	3, 4	Cytisus laburnum	2
Acer pseudo-platanus	4	Corylus avellana	6–8
Sambucus nigra	2, 3	Salix sp.	6–8
Cratægus oxyacantha ..	4, 5	Eucalyptus sp.	4
Ilex aquifolia	8, ?*	Juniperus communis	8
Cornel sp.	4	Wellingtonia gigantea ..	?*
Ailanthus glandulosus ..	4	Cedrus sp.	?*
Salisburia adiantifolia ..	12, 13		

In all of them I find the cambium composed not of prosenchymatous cells, but of prosenchymatous cell-groups, i. e. of cells so grouped, that the terminal ones of each group being more or less pointed at one end, the group is, as a whole, more or less prosenchymatous in form.

The number of cells so grouped varies with the species, and also in some species it varies within certain narrow limits. It may, however, be taken as true, that the longer the prosenchymatous elements of the mature wood are, the greater the number of cells composing the cambium cell-groups will be. Thus the figures placed to each name in the foregoing list of species, indicate the number of cells grouped together in the cambium; and it will be seen that in the Coniferæ, which possess the longest prosenchymatous wood-cells, there are from six to eight in Taxus, and twelve to thirteen in Salisburia; while in Cytisus, which has the shortest wood-elements I have seen, there are but two.†

That this is the true character of the cambium is proved from

* In these species, owing to the line of section being somewhat oblique to the course of the tissue, the numbers could not be counted satisfactorily, as frequently, owing to the comparatively great length of the group, the whole of it was not present.

† Each member of these groups is a complete cell, i. e. possesses a distinct nucleus, in which one or more nucleoli are to be seen. After the absorption of the transverse septa referred to in the next paragraph, the nuclei approach each other, and are frequently to be seen in a group near the centre of the young wood-cell. Coalescence of the nuclei appears now to take place. In Laburnum I have seen, first, a nucleus in each cell; after absorption, two nuclei partly overlying each other: and in wood-cells in which thickening is taking place, only one nucleus about twice the size of the original ones. The same remarks apply to one or two other species examined in this regard. In *Salisburia* fusion of the nuclei takes place undoubtedly so far as reducing the original number to half, while in size they are double. These remarks are founded on observations made on tissues in a state of rest, and since the date of the paper.

the fact, that in cutting a series of sections of the whole region referred to, it will be found, after leaving the parenchyma and soft bast, we find nothing but groups of cells as described, until the true wood is reached. Moreover, on the side next the phlœm we find the cambium passing over to parenchyma by the rounding off or further division of the individual cells, and on the xylem side we find the transverse septa absorbed, not always wholly or at once, for traces of them are often to be seen on the cell-walls even after thickening has commenced.

Thus in *Cytisus laburnum*, a species well adapted for study, it will be seen in Fig. 9, which is taken from a section adjoining the parenchyma of the bast, the cells are comparatively broad; that in Fig. 10, which is from about the centre of the cambium, they are narrower and proportionately longer, while the two combined cells are more decidedly spindle-like in form; and in Fig. 11, they have been still further modified in the same direction, the dividing transverse septa having disappeared—this figure being taken from a section next the xylem.

The same process in every respect is illustrated in Figs. 12 and 13, drawn from sections of *Syringa vulgaris.* Here the groups are composed of three and occasionally four cells. The modifications take place in exactly the same order; decrease in diameter, increase in length, and absorption of septa.

If we look at the development of the cambium in the other direction, or on the phlœm side, we should observe in Cytisus that as a rule each cell divides into two; and so we sometimes see on the outside of the tissue, groups with spindle-like ends composed of four cells; but growth very speedily obliterates the form, and intercellular spaces arising, we have a true parenchymatous tissue.*

Such then being the character of the cambium, it follows, that we can no longer regard prosenchyma as being composed of differentiated original elementary cells, for we find that they are like the vessels, but in a much more limited sense, cell-fusions.

This view of the structure of the cambium also involves of necessity a modification in the account given of the origin of other elements of the xylem, viz. the wood-parenchyma.

Sachs says † "They arise (i. e. the parenchymatous cell-forms of the xylem) according to Sanio by transverse division of the cambium-cells before their thickening commences." From this it would appear that Sanio saw these cell-groups in the cambium, but from some cause failed to observe that the whole of the cambium was composed of them. Sachs also figures these paren-

* With regard to the origin of the fibrous elements of bast, they appear to arise in two ways, viz. the combination and fusion of the cambium cell-groups, and also by the fusion of vertical series of parenchymatous cells. This point, however, has not been satisfactorily made out, and is reserved for further observation.

† Sachs' 'Text-Book of Botany,' p. 100, Oxford, 1875.

chymatous cell-forms, in the wood of Ailanthus,* the details of which correspond in every particular with my own observations, and the special elements under consideration also agree in form, dimensions, and number of cells in combination, with the cell-groups of the cambium. It is therefore naturally suggested that wood-parenchyma results simply from the non-absorption of the transverse dividing septa, and that while spiral or other thickening has taken place, yet their outward form is the same as it was when the group occupied its place in the cambium.

In the development of the vessels also there are one or two points of interest. In the mature vessel, the remains of what has hitherto been regarded as the original transverse septa, are always inclined more or less to the course of the vessel. That this should be so is apparent, if we take into consideration the fact that the cells from which they are developed are combined in the form now described; the septa, the remains of which we see upon the walls of the vessels, being the terminal ones of the cell-group, and therefore originally oblique, the intervening ones, which are at nearly right angles to their length, being wholly absorbed. In Fig. 15 is shown a portion of a section of *Sambucus nigra*, in which is seen a rudimentary vessel, the dotted lines indicating the position of the septa, the outer portion of which will remain upon the wall of the fully developed vessel. The transverse dividing septa are still present.

Another fact worthy of notice, is, that these oblique septa become before absorption in all respects like the septa of sieve tubes, being pierced with minute pores arranged in groups as shown in Fig. 16, drawn from a young vessel in *Ailanthus glandulosus*, the septa being very oblique and cut through. These pores gradually enlarge and coalesce, till either all the central portion is removed, or the bands which separate the sieve-like plates remain, forming the scalariform septum.

It would seem that absorption in cell-walls generally, or at least frequently, commences by this thinning down and piercing of the wall at minute points; for in the Coniferæ I find in the forming wood immediately adjoining the thickened tissue, similar sieve-like plates corresponding to the positions eventually to be occupied by the well-known coniferous bordered pits, whether it be on the radial walls of the tracheides, or on the medullary rays. This is well shown in *Salisburia adiantifolia*, and quite as certainly in all others that I have examined, though not always so readily to be made out.

The results of my observations may now be summed up, and from them it appears that the cambium-layer is not a portion of the procambium remaining over after the differentiation of the

* See London Science Class-Book, Botany, Morphology, &c., p. 40.

primary phlœm and xylem, but a special and new tissue developed from it; that it arises in the layer of procambium which is next adjoining the medulla or pith; the cells composing the cambium being developed by septation, in regular sequence, proceeding outwardly, till a tissue from six to eight cells in thickness is formed, the divisions then taking place in irregular order in those cells which form the three or four outermost layers.

That the cambium is composed of prosenchymatous cell-groups, the combined cells varying in number with the species to which the plant belongs. From the cambium on the phlœm side parenchyma is produced by the rounding-off, and sometimes by the further division of the individual cells, and prosenchyma on the xylem side by the absorption of the transverse septa; wood-parenchyma being simply those cambium cell-groups in which such absorption has not taken place.

That the vessels arise by the fusion of certain cambium cell-groups, which are arranged vertically with regard to each other; the oblique septa separating the groups being partly absorbed, and the transverse ones entirely so.

That absorption of the oblique septa appears to commence with the formation of sieve-plates, the pores of which enlarge and coalesce till either there is one large circular aperture through the centre, or the bands dividing the sieve-plates remain, forming the scalariform septa of some species.

XXXVI.—*Note on the Structure of the Scale of a Species of the Genus Mormo.* By Joseph Beck, F.R.M.S.

(*Read 8th October*, 1879.)

There is no subject which has been more freely discussed, and with such varying conclusions (not even excepting the much-vexed question of the structure of the siliceous valves of the Diatomaceæ), than that of the causes producing the appearance of "notes of exclamation markings" on the scales of several of the Thysanura.

It is not my intention to enter into a *résumé* of the views held by different microscopists, but simply to notice what I regard as a fresh proof that these so-called "markings" are due to a structure very different from what would be assumed were we merely to judge from the appearances that are apparent under the Microscope.

For some years I have maintained that the "notes of exclamation" markings on the scales of *Lepidocyrtis* are due to uneven *corrugations* in the membranes of which they are composed, and I have illustrated this before the Society by running moisture up and down the scale in the furrows between the corrugations or ridges. In the supplement to Sir John Lubbock's treatise on the Thysanura, I have used these words in describing the scale of *Lepidocyrtis curvicollis*, "Irregular striæ or corrugations from pedicle to apex broken up into large, well-defined separate 'notes of exclamation' markings; markings very black, with a light bright ridge down the centre of each; appearance due to irregular corrugations on the outer surface of the under membrane, slight undulations on the outer surface of the upper membrane, and to structure between the superposed membranes." I have produced a similar appearance by rubbing together two scales of *Polyommatus argus*, which scales have straight simple ridges running from pedicle to apex—when placed over one another at an angle *—but I have never until now been able to find a moth or butterfly scale which, in its natural condition, gave under the Microscope the appearance of "notes of exclamation" markings.

I now desire to call the attention of the Society to a scale from a specimen of the genus *Mormo* from the East Indies (I have been unable to obtain the exact name, having only the wing), which shows "notes of exclamation" markings very similar to those observed on many of the Thysanura. Under a low power these scales present the same watered-silk appearance seen in *Lepidocyrtis curvicollis*; under a $\frac{1}{8}$ they show the "notes of exclamation" markings; under a $\frac{1}{16}$ they are resolved into distinct ribs from pedicle to apex, *thus showing in one scale how the appearances run from*

* See Carpenter's 'The Microscope and its Revelations,' 5th edition (1875), p. 695.

one into the other, and adding another link in the chain of evidence in favour of what I have previously maintained, viz. that scales being expansions of the quill, require something to strengthen them, and that for this purpose they are all, whether amongst the Lepidoptera or Thysanura, supplied with ribs running from pedicle to apex, and that the varied appearances seen under the Microscope are due to the irregularities of the membranes of which the ribs form a part.*

* Since communicating the above I have, at the suggestion of the President, examined a large number of the scales of Lepidoptera, and I have invariably found that the corrugations are on one side only, and that side the under side, or the one nearest the body of the insect. Great care is required lest a mistake should be made by the moisture running between the scale and the slide, and not on the exposed surface only.

XXXVII.—*On New Methods for Improving Spherical Correction, applied to the Construction of Wide-angled Object-glasses.* By Professor E. Abbe, of Jena, Hon. F.R.M.S.*

(*Read* 11*th June*, 1879).

The correction of spherical aberration, in *dioptric* systems of all kinds, is based on the much-applied principle of compensating one deviation by an opposite deviation of the same kind. The positive aberration of the collective (convex) lenses of any system is balanced by the negative aberration of dispersive (concave) lenses. Besides this method there can be no other, as long as practical optics is confined to spherical surfaces.

Though this principle might be applied in various ways, one only has hitherto been adopted, which may be called the method of *allied* corrections. Spherical correction is always effected by concave lenses of the higher dispersive material (flint-glass), which are used for getting rid of the chromatic dispersion of the positive (crown-glass) lenses. The combination of a concave flint-lens with a convex crown-lens (generally cemented together) is the means of effecting both corrections at the same time, without being obliged to treat each separately. But of course it is not at all necessary that those binary lenses should be corrected, even approximately, in themselves. In the case of compound systems, as microscopic objectives generally are, one part of the system may be considerably under-corrected in each respect, provided it is balanced by an opposite deviation in the other part of the system.

The circumstance mentioned here—the possibility of correcting both aberrations by the same elements, *appears* to be a great advantage in the construction of objectives; and from one point of view it is in fact so, as it saves the unavoidable complication of separate concave lenses for spherical correction, in addition to those which are necessary for achromatism. But, on the other hand, this combination of the two corrections is the origin of a very serious defect, which becomes especially obvious in wide-angled systems. The amount of spherical aberration which is introduced by a lens of definite curvatures depends on its refractive index. Now the refractive index varies with the colour of the rays in both kinds of lenses, but in the flint the increase of this index, say, from red to blue, is much greater than in the crown, which is of course necessary for chromatic correction. In consequence of this the negative aberration in any optical system increases more rapidly from red to blue than the positive, and it is therefore impossible to obtain simultaneously the correct balance for different colours. If the compensation is got for the red rays, the negative spherical aber-

* The original paper is written by Professor Abbe in English.

ration of the flint lenses will be in excess for the blue; and if it is got for the blue rays, this negative aberration will be in defect for the red. The system, therefore, will be either spherically over-corrected for the blue or under-corrected for the red. Binary lenses especially increase this discrepancy to a great extent, the negative aberration in this case arising from the concave surface in which flint and crown meet together. This negative aberration therefore depends on the small difference of the refractive indices of flint and crown, which difference must of course vary from red to blue to a much greater extent than the refractive indices themselves, relatively.

The residual aberration considered here—"chromatic difference of spherical aberration" would be the correct name—is readily observed in any kind of dioptric system, Telescopes or Microscopes. The visible result of which must be (as may be easily demonstrated), a characteristic discordance of *achromatism* for the various zones of the aperture of any objective; if the central part of the aperture is well corrected chromatically, the peripheral zone must be over-corrected, and if the marginal rays afford the best possible achromatism the central rays must be under-corrected. This derivative defect of colour-correction must rapidly increase with increasing aperture, as it owes its origin to *spherical* aberrations (which vary with the *square* of the angles), and therefore becomes especially visible in such wide-angled systems as are used with the Microscope. Every attentive microscopist and optician will be familiar with its appearance in microscopic objectives, which always reveal a considerable difference of achromatism, in their performance with central and with oblique illumination. If an objective has the best possible colour-correction in the central part of its aperture (direct light yielding the secondary colours only), oblique light will show broad borders of yellow and blue on the outlines of the objects—the indication of chromatic over-correction of the marginal zone; and if the primary colours have been obliterated for the marginal pencils (rose or violet and green remaining only with oblique light), central illumination will give deep tints of red and blue on sensitive preparations such as organic tissues or the thick ribs of diatoms.*

These results of residual spherical aberration are of great practical importance. As they cannot be eliminated by the means hitherto applied, they represent an universal defect in microscopic objectives. Owing to this defect the performance of the best glasses is not equally satisfactory for every kind of work. An objective which has been corrected chromatically for central light will sometimes afford a well-defined and colourless image on

* This description will hold good for the central part of the field of vision only; for outside the axis the phenomena in question may be totally concealed by the much coarser chromatic effects arising from difference of *amplification* for different colours, which is never absent in wide-angled objectives.

delicate organic tissues or other similar objects, but it will show far too much colour, and, therefore, a great lack of definition when it is used on diatoms or other preparations requiring oblique illumination; and on the other hand a lens which has been made for the brilliant exhibition of diatoms may possibly be nearly useless for histological work.

This divergence would not be of much importance if objectives of especial excellence could be constructed for the one or for the other kind of work. But this is not the case, because the operation of the different zones of aperture is not really separated by different modes of illumination. Though the incident pencil may be either central or in the marginal zone, deflected and diffracted pencils will generally engage very different parts of the aperture, except in certain special preparations. Consequently the only rational plan for general work must be so to distribute these deviations as to prevent their accumulation in one part of the aperture. This is done by correcting the spherical aberration of the rays of predominant intensity (the yellow rays for visual performance), and compensating the greater part of the residual aberration of the red and blue by a moderate amount of chromatic under-correction—the plan now adopted, consciously or unconsciously, by the best opticians. But by the best possible distribution of these deviations they cannot be *eliminated*, but must always remain in the image, and to a certain extent debase the general level of the defining power.

In the year 1873 I expressed an opinion that the correction defect in question is the principal objection to the use of objectives of moderate focal length with deep eye-pieces, instead of the deeper lenses now required.*

It is now sixty years since C. F. Gauss, the celebrated mathematician of Göttingen, considered the above-mentioned aberration defect. He then discussed the problem of a more perfect correction of objectives, and suggested a plan for getting rid of the residual aberration in binary lenses made of ordinary crown and flint, for telescopic use. Unfortunately, his plan, which is disadvantageous even for telescopes, is utterly inapplicable to systems having the large apertures required in Microscopes. His method of correction, (without considering other difficulties) would need *uncemented* concave lenses of curvature so deep that even moderate apertures would make the angles of incidence approach, or exceed, the limit of total reflection from glass to air.

My own researches upon the subject, beginning from 1870, and having special regard to the Microscope, had for a long time a negative result—as far as the actual conditions of optical work were considered. From various practical difficulties every plan

* 'Beiträge z. Theorie d. Mikroskops.' 'Archiv mikr. Anat.,' Bd. ix. p. 425.

for correcting the residual defects spoken of *appeared* to be impossible, unless the connection between the correction of spherical and chromatic aberration could be removed.

On this supposition, which I afterwards found to be premature, I began to investigate the method of *independent* correction, which had never been considered before. I discussed the conditions for correcting the spherical aberrations of the convex lenses, or at least a part of these aberrations, by such other concave lenses as produce chromatic correction, and for this purpose searched for the appropriate means in systems not restricted to the low aperture of telescopic objectives. The general method could be easily indicated, as everything appeared to depend on one essential condition: viz. concave surfaces which would introduce negative spherical aberration, by difference of the refractive index of consecutive media, as in ordinary binary lenses, but would either exclude chromatic aberration of perceptible amount, or admit chromatic aberration of *opposite* character. The accessory requisites annexed to this would be somewhat different in the two cases, but would be accomplished without difficulty. The principal condition, however, indicated above, would require optical media essentially different from those hitherto applied. It would be necessary to dispose of two media which are to some extent unequal in refractive power, but either approximately equal in dispersion, or varying in opposite directions. Now, the various kinds of crown and flint glass differ widely in refractive index and in dispersive power, but the dispersion always varies with the index, the greater dispersion being associated with the higher index, and *vice versâ*, with very slight deviations. An independent correction of spherical aberration would require at least two kinds of glass, having optical relations different to those now in use—either low refractive index combined with high dispersive power, or high refraction with low dispersion. There is no reason for supposing the production of such a material an impossibility; but the makers of optical glass not having even thought of the problem at the time, any improvement of optical systems in the way proposed appeared to be postponed indefinitely.

Notwithstanding these difficulties, the principle thus indicated of independent correction of both aberrations has been put to a decisive practical trial. In order to obtain a clear view of the direction in which further improvement in the dioptric performance of objectives ought to be made, Mr. C. Zeiss, on my suggestion, undertook a very interesting and important experiment, not hitherto publicly recorded, by constructing some systems with *fluid* lenses, based on the principle of independent correction. For this purpose we availed ourselves of the low refractive indices of certain of the highly dispersive fluids which are to be found among ethereal oils

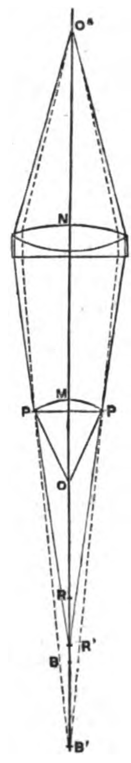
and artificial chemical preparations, selecting those fluids similar to crown, or light flint, in respect to refraction and equal to heavy flint in respect to dispersive power. Substituting a *collective* (convex) lens of such a fluid for one of ordinary crown (not a dispersive one for flint, as has been done for quite another purpose) and combining it with a concave lens of suitable flint of greater refraction and less dispersion, the dispersive power of the flint may be balanced by the dispersion of the fluid and from the difference of the refractive indices a sufficient amount of negative spherical aberration may be obtained, the chromatic variation of which is just opposite to that of ordinary binary lenses. At the same time the rapid increase of dispersion from red to blue in some of these fluids, if properly selected, will afford a simple and effective expedient for an almost perfect compensation of the secondary chromatic defects arising from the ordinary flint and crown lenses. The fluid uniting with the crown will make up the deficiency in the relative dispersion of the blue part of the spectrum of the crown in comparison with flint. Owing to this peculiar fact the plan indicated a degree of refinement of *both* corrections which, without taking into consideration the practical difficulties, could not be obtained, by ordinary means, at the time.*

In 1873 Mr. Zeiss made an objective on the plan in question; a dry $\frac{1}{4}$ (6·0 mm. focal-length) with a numerical aperture of 0·83, and another one in 1876, an immersion $\frac{1}{8}$ (3·0 mm.) of 1·15 aperture, a mixture of oil of cassia and of aniseed being used in the former, and pure Cinnamyle-hydrogen ($C^{18}H^{8}O^{2}$) in the latter. The refractive indices and the partial dispersions of all the materials having been measured very accurately, the formulæ were computed on the condition of perfect collection of spherical aberration for the two colours, D and F, and of very approximate correction of the axial rays for the three colours, B, E, and G. Both objectives were planned as quadruple systems, the latter with duplex front. The three anterior lenses are not essentially different from the ordinary construction; the back lens was made in each case of two glass lenses, flint and crown, including between them a fluid meniscus of collective character. Both objectives—which are still preserved at Mr. Zeiss' workshop—perform exceedingly well when their fluid contents are kept in good order. They yield images almost perfectly colourless on every kind of preparation and with every kind of illumination, with very superior definition — demonstrating the great improvement in

* Objectives have several times been announced as being free from secondary colours, owing to the application of three different kinds of glass. Anybody who has a clear notion of the conditions of achromatism will see at once, that such an assertion must have been either illusion or deception. For no kind of glass hitherto produced would admit of the collection of *three* different colours in one focus, even in a small telescopic objective.

dioptric performance which is attainable by a really perfect correction of spherical and chromatical aberration.

In consequence of the numerous grave drawbacks which attended objectives of such construction, the result of this troublesome and expensive experiment was considered by Mr. Zeiss and by myself as a matter of theoretical interest only—a glance at the Microscope of the future. But, as some of the principal difficulties would be considerably diminished in objectives for homogeneous immersion, owing to the omission of the correction setting, I am of opinion, that this method of independent correction under the new conditions is still capable of successful application in the improvement of high-power objectives.



In the meantime, however, another way of eliminating the chromatic difference of spherical aberration has suggested itself to me, reverting to the long-established system of *allied* correction.

In a recent investigation suggested by the introduction of the homogeneous-immersion system and during the attempts at still further increase of aperture, I touched once more upon the old problem, and observed that a device, which I had discussed in theory eight years ago, had not been then pursued to its legitimate conclusion, and that the residual defect of spherical aberration—though not simultaneously the secondary chromatic difference—could be got rid of by the ordinary means within reach of practical optics.

The general idea of the plan in question is shown by the diagram.

M N is an objective, O and O* the two conjugate foci of object and image; M (represented, for sake of simplicity, by a single lens in the diagram) the anterior part of the system considerably *under*-corrected spherically and chromatically; and N the posterior part, *over*-corrected in both respects, just sufficient for balancing both aberrations of the anterior part; N being separated from M by a relatively considerable distance. The continuous lines in the figure indicate the path of an oblique *red* ray, the dotted lines the path of the corresponding *blue* ray, both derived from the same incident ray O P.

The chromatic correction of the entire system being assumed to be perfect for the axis, red and blue rays of small obliquity starting from O will meet the axis at the same point O*; and supposing the system to be corrected spherically for the *red*, the *red* oblique ray will be collected to the same point O*. These two conditions can obviously be fulfilled in every system; but then in the ordinary

case the *blue* oblique ray would not meet the axis at O* but in a more distant point (not indicated in the diagram), owing to the spherical over-correction of the more refractive rays.

Consider now the action of the under-corrected anterior part of the system and the effect arising from the supposed distance between M and N. Owing to *chromatic* under-correction, the axial pencil emanating from O will have two different virtual foci R and B for red and blue after its passage through M; and owing to *spherical* under-correction of the anterior system, the oblique pencils O P after their passage will yield two *other* virtual foci R′ and B′ at a greater distance from O and from each other than R and B. The intervals R R′ and B B′ will indicate the linear amount of spherical aberration for the extreme colours, introduced by the front system M.

Owing to the positions of these four points the pencil of blue rays emanating from M will be confined to a smaller divergence than the red, and the sectional diameter of this pencil will be diminished, in comparison with the other, more and more from M to N. If now both pencils reach the concave surface of the correcting flint lens in the posterior system N, every blue ray will meet this surface at a smaller distance from the axis than the *corresponding* red ray, and therefore with a smaller angle of incidence; the difference increasing as the distance from M to N is increased. Owing to this difference the negative spherical aberration arising from the concave surface will be of less amount in the blue pencil than in the red, the action of this surface on the blue rays being somewhat similar to the action of a surface of less curvature; and thus the increase of negative aberration for the blue which at the same time arises from the greater difference of the refractive indices between flint and crown, may be exactly balanced. The whole pencil of blue rays will then be gathered to the same point O* where the red rays are collected.

As will be understood, this demonstration does not pretend to prove that the method here considered will attain the object in view *within practicable limits* in respect to the necessary amount of under- and over-correction, and the necessary distance between both parts of the system. This could only be done after an exhaustive mathematical analysis of the problem. The foregoing discussion is intended only to afford a clear idea of the *method* in general and to establish the principal *direction* in which the computations must be made in devising an objective according to this plan. This direction is readily expressed by the rule: combine a strongly under-corrected anterior system with an over-corrected posterior at such a distance that the chromatic difference of spherical aberration may be overcome—all other conditions of optical performance being taken in the ordinary way.

As is obvious from a glance at the diagram, this plan is connected with a peculiar difference of the image-forming pencils. Owing to the effect of the distance M N, the blue pencil must pass to the image with less angular convergence than the red one. According to the general theorem, established by Lagrange, this difference indicates a different *amplification* of the blue and the red image (the blue *larger* than the red), notwithstanding their identical position on the axis, or, expressed in another way, a chromatic difference of focal length, coexisting with identical position of the conjugate foci for different colours. The practical result of this deviation must be a defect of achromatism *outside* the axis. The images of different colours coinciding on the axis, the centre of the field will appear perfectly achromatic; but the blue image overlapping more and more the red one, coloured outlines will appear outside the centre, increasing with the distance from the axis.

Achromatic defects of this kind are of subordinate importance, as they do not injure the definition in the central part of the field, They are to be found in all objectives of somewhat considerable aperture, and are generally overlooked by microscopists, though the difference of amplification in such object-glasses exceeds 1 per cent. (the more brilliant rays of the red and blue considered only), and much more still in systems with duplex front. But such defects of amplification, if they become too obvious, may be easily corrected either by specially constructed eye-pieces or by a separate correcting lens added to the ordinary eye-piece. Hence the fact above noticed, though not of course advantageous, is no serious objection to the plan here considered.

On the other hand this mode of construction much facilitates the correction of another kind of amplificatory defect of still greater importance, which cannot be overcome by the eye-pieces or similar means, but must always be corrected in the objective. What is generally called by microscopists "curvature of field," is in fact in its principal part the result of different amplification by different zones of the aperture,—the axial pencil yielding a different linear amplification of the image to those of the various oblique pencils; and for correcting these anomalies, which are a grave difficulty in the construction of wide-angled systems, the elements of a separated posterior lens can be readily made available.

Respecting the practical application of this plan of correction, it can be used in both telescopic and microscopic objectives. But in telescopes of small and moderate focal length the residual spherical aberration is not of any practical importance; and in large objectives, where it has an injurious influence, there are much greater aberrations arising from the disproportional dispersive powers of crown and flint (secondary colours). As long as these exist the

advantages of a more perfect spherical correction are inappreciable, and the subject in question will have no practical interest for telescopes, unless the manufacturer of optical glass makes considerable progress towards a better conformity in the dispersive powers of crown and flint.

In microscopic object-glasses the secondary dispersion, though also perceptible, and the removal of which would be a considerable improvement, is not nearly so injurious as residual spherical aberration, because the latter increases so rapidly with increase of aperture. There can be no doubt therefore that objectives, even of moderate aperture, would, by the correction of the chromatic difference of spherical aberration, attain a much higher standard of defining power than has been hitherto obtained; and if there be microscopists who appreciate a luxurious exhibition of optical art, they will, I hope, be gratified by seeing opticians apply this plan of correction to objectives of various powers. But the practical advantages of more complicated and more expensive constructions will remain somewhat questionable in the case of those moderate apertures, the full performance of which can be obtained (without inconvenience from too short a focal length), with good ordinary objectives. For a moderate aperture needs only a moderate amplification for the full exhibition of the minutest details accessible to the aperture. Such an amplification may be obtained by an objective of relatively long focal length, if the dioptric refinement admits of a large increase of amplification by means of deep eye-pieces; in the other case it must be got by an objective of shorter focal length, requiring low eye-pieces only for the same amplification. Though from the purely optical point of view the former is the more perfect instrument, the latter will be practically the same, as long as a moderately short focal length is still sufficient for the aperture. Now even the largest aperture attainable by dry lenses will need no higher amplification for perfect exhaustion of the microscopic image than may readily be obtained by a good $\frac{1}{8}$ of the ordinary construction combined with rather low eye-pieces; at all events no observation of any scientific value has ever been made by any dry lens, which could not have been made just as well with an $\frac{1}{8}$; and there is no practical inconvenience in the case of such a glass, if it be properly made, which would not occur to the same extent with a more accomplished $\frac{1}{4}$, fit for replacing it by means of deeper eye-pieces. The more substantial advantages will, therefore, be derived from the removal of residuary aberrations for the higher apertures alone, which are obtained by the immersion system, and especially in the case of homogeneous immersion; for in these cases higher amplification is needed than can be effectively obtained by an $\frac{1}{8}$ with the ordinary mode of correction. Raising the level of dioptric performance in those objectives will remove

the very short focal lengths, which are so inconvenient in use and scarcely less difficult in workmanship.

According to this consideration, the plan in question has been applied practically to the production of an objective of very large aperture on the homogeneous immersion system. The formula has been computed on the condition of equal spherical correction for two different colours (D and F) for a focal length of 3·0 mm. ($\frac{1}{8}$), and an aperture of 1·40 numerical = 138° balsam angle—the widest angle, probably, which has been hitherto attained, as it already exceeds by several per cent. the utmost aperture for water immersion, and approaches within 7 per cent. the possible maximum, which is consistent with balsam-embedding and crown-glass covers. The system is planned on the duplex-front construction. In order to use a moderate curvature (shortest radius 1·30 mm.) the front has been tasked in an unusual way: it has been made active up to 6° beyond the equator of the sphere, a surface exceeding the hemisphere by about $\frac{1}{10}$ of the radius thus being applied as a clear lens.* The angles of incidence of the rays increase up to 44° on the air side of the front lens, but do not exceed this amount at the anterior surface of the second lens. The anterior part of the system (corresponding to the lens M of the diagram) is made as a quadruple system, two binary lenses above the duplex front; the over-corrected posterior part (N) of relatively great focal length is a triple lens, the flint cemented between two crown lenses, and the distance between the opposite surfaces of both parts is approximately three times the focal length of the entire system. Though it would have been possible in this case to make shift with three separate lenses in the front part, I preferred to take four, in order to deal with lower curvatures; the good success of the quadruple systems having practically proved that the slight loss of light and the slight increase of diffused light by one lens were more than counterbalanced by the advantage of surfaces of lower curvature. The computation of the formula was based on the supposition of an immersion fluid of a refraction exactly identical with that of the covering glass, 1·518 to 1·520 for the D ray.

* As a hyper-hemispherical lens cannot be set into the brasswork in the ordinary way, it was necessary to fix it by means of a parallel plate cemented on, fixing the slightly prominent edge of this plate—a device applied already by Mr. R. B. Tolles, as I am told. Avoiding the difficulties connected with this unusual shape of the front lens, would have needed a much stronger curvature of this front for obtaining a focal length of 3 mm. But then its focal length would have been considerably less than the focal length of the entire system, and the objective would have been similar to a much stronger one in all practical respects. The advantage of a lower power depending only on the greater focal length of the front lens, the aim must be to keep this focal length as great as possible. By the construction considered above it is obtained only slightly less than the focal length of the entire objective.

The lenses having been ground and set in the brasswork with all possible care, according to the formula, the two made at the workshop of Mr. Zeiss were perfectly corrected by a very slight alteration (some hundredths of a millimetre) of the distance between the second and the third lens of the front part. The apertures of both objectives, observed with the light of a soda flame, was found 1·40 to 1·41 by means of an apertometer with flint-glass disk and the same by an independent micrometric method. Notwithstanding the various delicate and novel manipulations which were necessary for exact polishing and setting of a front lens of this peculiar kind, the performance of the two objectives was perfectly satisfactory. The resolving power gave evidence of the increased aperture. Ordinary specimens of *Amphipleura pellucida* are rather coarse test-objects with an aperture of this amount, as they are resolvable by a moderately oblique pencil. There is no doubt that on balsam-mounted preparations, striations up to 5000 lines per millimetre (125,000 per inch) would be readily resolved by an incident pencil of the utmost obliquity, and still finer photographically. The difference of chromatic correction between the central and the marginal zone of the aperture is in fact imperceptible; the middle of the field yields nearly white images, with central light, and secondary colours only, with light of extreme obliquity. The definition with the deeper eye-pieces proves decidedly superior to the objectives of similar focal length, made for homogeneous immersion on the ordinary plan of correction; and as the other circumstances connected with this construction are somewhat less favourable, there can be no doubt that the improvement is due solely to the removal of the residuary spherical aberration.

As was anticipated from the formula, the chromatic difference of amplification appeared much more perceptible than with other objectives. I added therefore a correcting lens below the eye-piece—a convex flint- and a concave crown-lens cemented together, calculated for neutralizing one another in respect to the middle rays of the spectrum, but with exceeding chromatism of the flint. This lens therefore performs like a plane parallel plate for the middle rays, as a collective lens for the blue, and as a dispersive lens for the red rays. Inserted at the end of the tube by a suitable adapter at a short distance from the field-glass of the ocular, it introduces—owing to its position—no perceptible aberration, neither chromatic nor spherical; but it corrects the path of the coloured pencils *outside* the axis by continuously increasing prismatic deflections. This device performs quite satisfactorily with all eye-pieces, except very low ones.

For photographic performance an objective of this construction

would not need a separate correcting lens, as this could be combined with the concave "amplifier" introduced by Dr. Woodward for preserving the right position of the conjugate foci, while the image is projected to a considerable distance. This amplifier may be readily made use of for correcting every difference of amplification, provided it be not made achromatic, but rather over-corrected chromatically to a proper degree.

Some difficulties, arising from the nature of the immersion fluid, which at first occasionally interfered with the satisfactory performance of the objectives in a rather vexatious manner may now be considered as overcome. As the difference in the refractive index between oil of cedar-wood and the covering glass seemed to me too great for the increased aperture and as the stronger oils or mixtures of oils are of too great dispersive power, I was obliged to abandon these liquids. The solution of anhydrous chloride of zinc, which can be easily concentrated up to the refraction of covering glass, by using a refractometer or a test-bottle with a crown-glass prism of 1·518, at first appeared to be the best substitute. But it was found that in the high concentration needed here the solution is subject to sudden changes unless it is perfectly free from the ordinary hydrous salt. This may be obtained by very careful preparation, and the liquid then performs very well—provided it be preserved in a tight bottle and prolonged observation with the same drop be avoided, but I prefer now a solution of chloride of cadmium, or of sulpho-carbolate of zinc, in strong glycerine, which can be brought to the right refraction. They are rather sticky it is true, and in this respect less convenient for use; but as they are not nearly so hygroscopic as the chloride of zinc, they can be applied with much more ease. With sufficient cleanliness none of these liquids, not even the chloride of zinc, will do any injury to the lenses or to the stands. The application of *strictly* homogeneous immersion has, therefore, no serious drawback, even if a more convenient liquid should not be hereafter discovered, as may still be hoped.*

As the result of the practical trial here recorded, I consider the three following facts as sufficiently established:—

1. The chromatic difference of spherical aberration may be overcome even in wide-angled systems by means of the ordinary methods hitherto applied in optical construction.

2. By the removal of this defect of spherical correction in

* Microscopists who are connected with chemical matters are kindly requested to promote the homogeneous immersion method by looking out for such less known liquids as afford some hope of being useful for the purpose, and I shall be glad to investigate every sample which may be sent to me for trial. A few drops only, is quite sufficient for exact measurement, by means of the refractometer, of the refractive and dispersive indices.

microscopic objectives a useful improvement of the dioptric performance (definition) is obtained even when the defect of secondary chromatism cannot be removed.

3. The homogeneous immersion system admits of a useful increase of aperture closely approaching the ultimate limit which is imposed by the optical qualities of the materials hitherto available for microscopic preparations.

XXXVIII.—*On the Anatomy of Leptodora hyalina.* By H. E. Forrest.

(*Read 12th November*, 1879.)

Plates XXIV. and XXV.

Leptodora hyalina is a very interesting Entomostracon, which has only recently been added to the British fauna. It was discovered in this country on the 19th July, 1879, in Olton reservoir, near Birmingham, by Mr. J. Levick, who with several fellow-members was on an excursion of the Birmingham Natural History and Microscopical Society. Sir John Lubbock read a paper on it at the meeting of the British Association at Sheffield, and a short description of it is given in the 'Midland Naturalist' for September, by Mr. W. Graham. Up to the present time, however, nothing has been published in England upon the anatomy of the animal, and it is hoped that the following remarks may be useful both to those who have seen it, and those who have not had an opportunity of doing so.

I will describe first its external structure, next the digestive apparatus, then the nervous or sensory organs, and lastly the reproductive organs, and differences between the sexes.

EXPLANATION OF PLATES XXIV. AND XXV.

Fig. 1.—Lateral view of male *Leptodora hyalina*, to the first abdominal somite.

„ 2.—Dorsal view of the entire male animal. *a*, eye. *b*, cerebrum, or brain ganglia. *c*, antennules. *d*, commissure. *e*, cephalostegite, or head shield. *f*, antennæ. *g*, 1 to 6, legs. *h*, upper lip. *i*, lower lip. *j*, mandible. *k*, thorax. *l*, heart. *m*, omostegite, thoracic shield, or carapace. *n*, kidneys. *o*, 1 to 4, abdomen. *p*, œsophagus. *q*, pharynx surrounded by salivary glands. *r*, stomach. *s*, rectum. *t*, anus. *u*, terminal hooks of the abdomen. *v*, ligaments, to the ends of which the muscles of the antennæ are attached. *w*, ditto for muscles of the six pair of legs. *x*, œsophageal collar. *y*, testis.

Fig. 3.—Antenna viewed from beneath. *a*, muscles. *b*, nerves.

„ 4.—Seta from branch of antenna. *a*, nerve entering from below, and terminating on diaphragm between the joints.

Fig. 5.—Carapace (omostegite) of female, with ova arranged round it, and showing the opening which fits over the abdomen.

Fig. 6.—Ideal section of ditto, showing the incurved edges and ovum *in situ*, one on each side.

Fig. 7.—Side view of terminal abdominal hooks.

„ 8.—Antennule of male, showing the nerve entering from below and traversing the whole length, giving off branches to each of the truncated setæ.

Fig. 9.—Ditto of female.

„ 10.—Mandible, showing teeth on point.

„ 11.—Head of female. *a*, outer membrane of eye. *b*, crystalline tubes. *c*, pigment mass. *d*, muscles of the eye. *e*, *f*, right and left ganglia of brain. *g*, nerves of the antennules. *h*, commissure connecting the brain with the thoracic ganglia. *i*, dark oval bodies. *j*, basal ganglion.

Fig. 12.—Dorsal view of the heart, showing only the surface muscles.

I. *External Structure.*

The general appearance of Leptodora is shown in Fig. 2. The body, which is long and straight, is of nearly the same width throughout. It measures from $\frac{1}{4}$ inch to $\frac{1}{2}$ inch in length and about $\frac{1}{20}$ inch in greatest breadth. The division into head, thorax, and abdomen is well marked. The head (Fig. 1, *a–h*) is apparently of one piece, having no traces of segmentation. In shape it is a rounded column, gradually expanding towards the base, and slightly flattened on the ventral side. On each side of the eye there is an antennule (= the superior antennæ of Baird), which is long and tapering in the male (Fig. 8), but short and claviform in the female (Fig. 9). Just above its junction with the thorax the head is covered, dorsally, by a saddle-shaped shield (= cephalostegite of Huxley), beautifully constructed of flat polygonal cells, each with a raised dot in the centre of it (Fig. 1, *e*). Almost opposite this, on the ventral surface, is the mouth, one of the most extraordinary I have ever seen. In the Crustacea we are accustomed to find a complicated arrangement of maxillæ, palpi, and other hard structures. In Leptodora we find, however, simply an upper and lower lip, soft and mobile, the upper fitting over the lower like the two halves of a duck's beak. When the animal requires to open its mouth it calls into play a set of muscles which cause the upper lip to wrinkle and curl upward in a manner which cannot fail to strike the observer as comical. The lower lip, which is the same shape as the upper, possesses little or no mobility; it almost rests on a kind of platform, formed by the top of the thorax (Fig. 1, *h*, upper lip; *i*, lower lip).

On each side of the body, between the cephalostegite and the thorax, are attached the antennæ (= inferior antennæ of Baird), joined to the body by several wrinkled folds of the integument (Figs. 1 and 2, *f*). Each antenna consists of a large, broad, and slightly flattened arm, divided at the end into two branches (see Fig. 3) of four joints each. The arm is not setose, but the three distal joints of the one branch bear nine, six, and nine setæ respectively, and the four joints of the other branch bear four, nine, five, and six setæ respectively. These are the usual numbers, but they vary slightly in different individuals. Each seta (Fig. 4) is divided into two, and occasionally three joints, and tapers off to a very fine point. The sides are delicately fringed with hairs of extreme tenuity, so closely set that the whole forms a kind of oar almost impervious to water; presenting, perhaps, the largest possible surface, at the smallest expenditure of material. The antennæ are used solely as organs of locomotion, i.e. as swimming organs. Their motion is chiefly perpendicularly up and down. Though

at the same time the animal progresses *forward*. This forward motion is no doubt due in part to a slightly backward direction of the down stroke, but I think that it is also largely due to the structure of the antenna.

As I have pointed out, the flattened oar-like end of this organ is jointed, and therefore flexile. At each downward stroke it bends upwards, at each upward stroke it bends downwards. The setæ all taper to the point, so that the base is stronger than the point, and the weakness increases gradually upwards: consequently although the normal position is straight, the force of the impact of the water causes it to yield and bend, and this yielding is greater towards the point than at the base, and since they are all united so to speak, into a compact plate by the fringes on each side, and are all acted upon at once, the whole surface of the oar assumes a curved form, and strikes the water obliquely, instead of flatly, and the animal is in consequence driven forward. My meaning will probably be clearer, if I say that the principle which causes the oar of Leptodora to glide *forward*, is exactly the same as that which causes a rower's oar to glide *downwards* when he dips it into the water obliquely and "catches a crab." At each stroke of the antennæ the direction of the slope is reversed, so that both the upward and downward stroke drive it forward. The direction of the hairs which fringe the setæ (Fig. 4), is also such that it is easier for the water to pass over than between them.

The thorax (Fig. 1, *k*) is that part of the body which bears the legs. It consists of seven somites which have anastomosed so thoroughly as to leave no traces of the original segments, and indeed we can only guess their number from the number of pairs of appendages. Six pairs of these (Fig. 1, g^1–g^6) take the form of legs, and are placed in a semicircle around a kind of platform formed by the top of the thorax. Although they vary immensely in length, they are all constructed exactly alike, each consisting of four rounded joints provided with setæ. The smallest pair (Fig. 1, g^1) is in the middle of the semicircle, and each succeeding pair is longer than the last, the sixth being so long that they meet far above the head (Fig. 4). The three smaller pairs are curved upwards and towards the mouth, the three larger ones in the opposite direction towards the last three.

The flexure of the limbs naturally leads to the supposition that they are used for capturing prey, and their arrangement round the mouth is such that no animal once within their pale could well escape running the gauntlet between those ferocious-looking organs of destruction, the mandibles (Fig. 1, *j*). These last are the seventh pair of thoracic appendages, modified for manducatory purposes. It is remarkable that none of the limbs are converted into branchiæ such as we find in the Daphniadæ. The dorsal side

of the thorax below the limbs is expanded into a hoodlike carapace (= omostegite of Huxley), which is small and attached all round to the body in the male (Fig. 1, *m*), but large and open below in the female (Figs. 5 and 6 in section). The abdomen (Fig. 1, *o*), (Fig. 2, *o* 1–4), consists of four somites of unequal length, but nearly the same width; the terminal one is divided at the end into two long sickle-shaped hooks (Figs. 7 and 4, *u*) covered with short flat spines, a row of larger ones along the inner edge.

II. *The Digestive and Circulatory System.*

The alimentary apparatus of *Leptodora* is very simple. The mouth I have already described. The bases of the mandibles (Fig. 1, *j*) are embedded in a muscular bulb in the thorax, but the points are free and project into the mouth, one on each side, at the junction of the upper and lower lips. Their points are armed with three or four projecting teeth (Fig. 10). Whenever the mouth opens these mandibles begin to work towards each other across the opening of the œsophagus, tearing the food as it passes between them. The food consists chiefly of small water insects and other living things. The pharynx (Fig. 1, *q*) is not always open, and I have seen it opening and shutting as if it were closed by a sphincter muscle. It passes straight backwards as far as the roots of the mandibles, and is surrounded by a number of cells, which are probably salivary glands. It passes between the mandibles and then curves suddenly downwards, and enters the œsophagus, a long tube traversing the centre of the abdomen as far as the last somite but one, where it is expanded into a stomach the walls of which are corrugated interiorly. The anus is situated between the terminal hooks, at the end of a short rectum (Fig. 2, *s*).

On each side of the heart there is a long dark vessel (Figs. 1 and 2, *n*), which is probably a kidney. It is bathed all round with the blood, and would no doubt secrete the urine from it as it passes. It is divided at the end into two lobes, one of which is of a darker colour than the other. A long duct leads from it upwards into the centre of the thorax, where it gets lost in the mass of muscles and nerves which crowd this part, so that I have not been able to trace them any further. I think, however, that the ducts enter the œsophagus, and their contents then find their way out through the same opening as the other fæcal matters.

There is no trace of a liver, but probably the walls of the stomach secrete some fluid analogous to the gastric juice. The circulatory system is also very rudimentary. The heart (Fig. 1, *l*, Fig. 2, *l*, and Fig. 12) is a perfectly transparent sac encircled with numerous muscles, situated in the centre of the thorax, to the sides

of which it is attached by slender ligaments of connective tissue. Fig. 12 is a dorsal view of the heart showing the arrangement of the muscles. It pulsates very rapidly, pumping the blood along just like a pair of bellows. *Leptodora* cannot be said to have any true arteries or veins, the blood merely courses along the interstices between the organs of the body. The corpuscles are amœboid, colourless, nucleated, and remarkably few and far between. At each contraction of the heart the blood is driven forward through an opening at the end nearest the head, where there is a valve which prevents its return when the heart re-expands. The blood then enters at the opposite end, to be in its turn driven forward, and so on *ad libitum*. It is very remarkable that *Leptodora hyalina* has no organs set apart for respiration. In the other Cladocera we always find some of the limbs flattened and otherwise modified so as to serve the purpose of gills, but in *Leptodora* the whole body wall is so thin, and consequently the whole body so thoroughly exposed to the oxygenizing influences of the water, that the specialization of any parts for breathing organs is unnecessary.

III. *Nervous System and Sensory Organs.*

The nervous system is more highly developed than might be expected from the otherwise low organization of the animal. It shows a degree of concentration almost equal to that of the spider crabs (*Maia*). There is a large brain mass or cerebrum in the front part of the head, and the eye rests immediately upon it (Fig. 1, *a* and *b*). The cerebrum is indistinctly divided into three parts. Two upper right and left parts (Fig. 11, *e* and *f*), and one basal part (Fig. 11, *j*), probably the remains of three ganglia which have coalesced. The basal part gives off a large nerve (*g*) to each of the two antennules. Each nerve gives off branches to the setæ with which these organs are studded, and it is remarkable that they differ materially from the setæ found on other parts of the body, being truncate instead of pointed (Fig. 8, male; 9, female). Hence the end of each nerve is exposed almost naked to the water, making the antennules most delicate sensory organs.

What their precise function is, is a moot point, some authors say they are for hearing, others for smelling. Sir John Lubbock in his recent paper read before the British Association fully discusses this question, and concludes that the latter is the most probable, because the antennules are much more developed in the males than in the females. If one sex attracts the other by sound, both sexes would have the ear developed, for the attracted sex must be able to distinguish the sound, and the singing sex must have a good ear

to regulate the sound. In such a case there would not be much difference between the organs of hearing in the male and female. But if one sex attracts the other by smell, it is not necessary that the attractive sex (female in this case) should have well developed organs of smell. If the antennules were hearing organs, I still do not see how they would be available for bringing the sexes together, for the assumption that the male can produce any sound is pure hypothesis, and so soft are the parts of its body that I doubt whether such a thing is possible; indeed the whole evidence is so strongly in its favour that Sir John Lubbock's conclusion is evidently the right one.

The eye is a most beautiful organ. If viewed laterally (Fig 1, *a*) it appears globular, but is not really so. Seen from beneath (Fig. 11) it is found to be reniform, composed of a series of cuneiform crystalline tubes (Fig. 11, *b*) with rounded extremities, but not so closely appressed as to become hexagonal. These are enclosed in a very transparent membrane (Fig. 11, *a*), and radiate from a dark-coloured pigment mass (*c*) in which their inner ends are embedded. This eye is remarkable for exhibiting a distinct tendency to become two eyes as in the higher crustacea. Down the centre of it (Fig. 11) there is drawn a faint line, which in the lower half widens into a considerable gap, where there are no crystalline tubes, the right and left halves thus formed corresponding to the right and left cerebral ganglia (Fig. 11, *e* and *f*). In some specimens this gap is much more distinct than in the one figured. We see the same thing in the larva (Zoea) of the prawn, which has one eye, but later on two eyes. The eye of *Leptodora* too, is much in advance of that of the other Cladocera, in which it consists of a pigment mass with a few irregular crystalline sacs attached to it. Between the upper and lower ganglia of the brain there are several dark oval bodies (Fig. 11, *i*), whose function I cannot guess. The basal ganglion gives off a large commissure (*h*), which bifurcates, in some specimens close to, in others at a considerable distance from its origin; the two halves being very much thickened as they pass one on each side of the œsophagus to form the œsophageal collar (Fig. 2, *x*). They meet on the opposite side, in a large nerve mass formed by the coalescence of all the nerve centres of the thorax and abdomen into one. This mass is situated between the bases of the six pairs of legs and the mandibles, and gives off nerves, one to each leg, one to each side of the abdomen, and one larger than the others to each antenna. These nerves of course give off smaller branches innumerable, but I need not describe them further than to say that every individual seta is provided with one. In the large setæ on the antennary branches (Fig. 4, *a*) the nerve terminates on the diaphragm between the two joints.

IV. *Muscles.*

Probably in no other animal is muscular action and structure displayed more beautifully than in *Leptodora*, for on account of its transparency the muscles may all be seen *in situ* without any dissection. The most powerfully developed are those of the antennæ, which are shown from a dorsal aspect in Fig. 2, *f*, and from beneath in the larger drawing (Fig. 3, *a*). The immense power of these muscles requires that the point of attachment should be very firm, but the body wall of the thorax is much too soft to bear the strain, so instead of being attached to it, they are fastened (Fig. 2, *v*) to the ends of two ligaments which pass right through the thorax, and are only fastened to the body wall by threads of connective tissue. Thus the two opposite antenna-muscles actually pull against one another, and the whole strain is borne by the ligament between them. The six pairs of legs are each provided with a muscle, and their ends too are attached to ligaments between their bases (Fig. 2, *w*), and the right and left sides pull against one another. A large flat muscle runs down each side of the body, and is attached to each somite, the final attachment being to the sides of the terminal somite, almost at the end of the stomach (Fig. 2, *r*). The rectum (*s*) is opened and closed by a set of sphincter muscles, and so is the pharynx, as I have already mentioned. The muscles which move the lips are attached at one end to the lips, at the other to the ventral or dorsal sides of the head (see Fig. 1). The eye has six muscles fastened to it at six different points, about equal distances from one another (Fig. 11, *d*). These are constantly in motion, causing the eye to perform a quarter of a revolution in one direction, then to revolve the same distance in the opposite direction, and this movement does not seem to be under the control of the animal, as it is as incessant, though not so regular as the beating of the heart. The muscles which encircle this last-named organ are distinctly striate (Fig. 12), and distributed over its surface in irregular loops.

V. *Sexual Differences.*

In *Leptodora*, as in most of the Cladocera, the female is larger than the male. In August, when I first began to collect them, the females were much more numerous than the males; but later on the males appeared in goodly numbers, and finally, in October, there were as many males as females, if not more. Now (November) both sexes have entirely disappeared, and I much regret that I am not able to give a drawing of the ovaries, as I neglected to mount a female specimen, supposing I should be able to procure them alive at any time. I have seen them, however, very often, so am not at a loss how to describe them. They are elongated

dark-coloured organs, fastened by one end to the inside of the wall of the abdomen, close to the junction of the first and second somites. The inner ends are free, the right-hand ovary projecting into the abdomen downwards; the left upwards. When much distended with eggs they sometimes nearly fill the abdomen. My friend Mr. W. P. Marshall informs me that he saw one female with a row of eggs the whole length of the abdomen, but I did not see the specimen myself. The oviducts open on to the surface between the second and third somites. The eggs, after extrusion, are carried about in the carapace of the mother until hatched. The way in which they are kept in their places is very remarkable. The carapace (omostegite) is much larger in the female than in the male (Fig. 5, female, and 1, *m*, male), shaped like the bowl of a spoon, with the edges produced and curled over inwards. It is this incurvature of the edges which prevents the eggs from tumbling out of the carapace, as shown in Fig. 6, which is an ideal section of the carapace and abdomen showing two eggs, and the way in which the opening is closed below by the top of the abdomen. The eggs are always arranged round the carapace, never in the middle, and the greatest number I have seen within it at one time is six. I am indebted to Mr. J. Levick for a specimen showing the structure of the female carapace very clearly.

The testes (Fig. 2, *y*) occupy the same position in the male as the ovaries of the female. They each consist of an elongated, transparent sac, pointed above and below, and connected together by a saddle-like band. They are filled with sperm vesicles, most thickly congregated towards the upper end. As my paper only treats of the anatomy of the animal, I cannot enter into the subject of its development, although it is highly interesting.

VI. *Zoological Position.*

Leptodora hyalina was placed by Lilljeborg in the Branchiopoda, Order Cladocera, and Family Daphniadæ, and his placing has since been admitted by other naturalists without demur; but, during the last two months, I have had the animal under close observation, and the more I study it the more the conviction grows upon me, that its departure from the type is so great that one of two things must happen. Either the diagnosis of Cladocera and Daphniadæ must be altered in order to admit the species, or else *Leptodora* must be placed in a separate order and family. The following is Baird's description of the order Cladocera, condensed.

Body, except the head, enclosed in a bivalve carapace hinged at back. Feet four to six pair, articulations chiefly branchiform, not adapted for locomotion. Eye single, large. Antennæ two pairs, inferior branched, large, and adapted for swimming. Mandibles without palpi.

In the 'Micrographic Dictionary,' the first part of the diagnosis which speaks of the body being enclosed in the carapace is omitted, but even in this revised form it will not admit *Leptodora*.

I don't understand why Lilljeborg placed *Leptodora* in the family Daphniadæ, which is defined thus: "Superior antennæ very small, inferior large with two branches. Legs five or six pairs all enclosed within the carapace." As the carapace of *Leptodora* is so small that it does not completely cover one somite of the abdomen, much less any part of the legs.

The probable explanation is that Baird's arrangement was founded only on those British Entomostraca with which he was acquainted, and under these circumstances it will, I suggest, be best to place *Leptodora* in a family by itself, and to modify the Cladocera as defined in the 'Micrographic Dictionary,' by the alteration of a single word.

Order, Cladocera. Legs four to six pairs, *generally* branchial; eye single, and very large, antennæ two pairs, inferior large, branched, and adapted for swimming.

Family I. Daphniadæ; Family II. Polyphemidæ; Family III. Leptodoridæ. Inferior antennæ very large, two branched, both four-jointed. Legs six pairs, none of them branchiform. Carapace very small, not enclosing the body. Young passing through a metamorphosis from the winter egg.

VII. *History.*

Leptodora hyalina was first discovered by Dr. Focke, who found it in the moat of the city of Bremen in 1844, and exhibited it at a meeting of the Natural History Society of that place. It did not however receive any name until 1860, when it was described in the 'Transactions' of the Swedish Academy by Lilljeborg, who had found it in the Swedish lakes. His treatise is written in Swedish, but he gives a long Latin diagnosis. Müller was the first to find the male in the Lakes of Constance, Geneva, and Denmark. Nicolaus Wagner discovered it in 1868 in Russia, in a lake near Kasan, and not knowing that Lilljeborg had already described and named it, he gave a description and four plates of it under the name of *Hyalosoma dux*. In 1873, Sars published some notes on the development of the winter eggs. In 1874, Dr. August Weismann published a very elaborate and careful paper on its anatomy, with six plates, in the 'Zeitschrift für wissenschaftliche Zoologie,' vol. xxiv. Through the kindness of Mr. Crisp, I have been able to examine this paper, which was translated for me by a lady friend, and I find that there are one or two points on which my observations do not agree with his. He draws all the setæ on the branches of the antennæ equal in length, which in my view is not

correct. He does not appear to have noticed the incurved edges of the female carapace by which the eggs are held, as he figures it merely as spoon-shaped, and states that the eggs are held in their places by transparent threads. I have not been able to detect these threads, but would not venture to deny their existence. He also states that the dots on the cephalostegite are the openings of glands; if so, they would open inwards, but they appear to me *raised* spots on the outer surface, and not openings at all. I do not know whether he observed the polygonal markings on this shield, but he does not figure them. He also contradicts Wagner's assertion that bristles occur on this part of the body, and considers that what Wagner took for bristles were parasitic fungi. I have noticed that almost all my specimens had the cephalostegite and sometimes other parts of the body covered with the frustules of a diatom (*Synedra*), which at a casual glance might easily be mistaken for bristles. Probably this was the cause of Wagner's error.

Two things would tend to prevent the earlier discovery of *Leptodora* in Britain: first, its extreme transparency; and second, its habit of frequenting open and deep water, for it is usually found at a depth of three or four feet. A naturalist hunting for Entomostraca, would probably only dip for them in the weedy shallows where they mostly congregate, and would thus come away without procuring a single *Leptodora*, even in a pool where they abounded. Swimming in open water, the animal is of course exposed to the attacks of fishes, and no doubt its transparency is then a great protection to it. It would also serve to conceal it from any prey on which it is stealing.

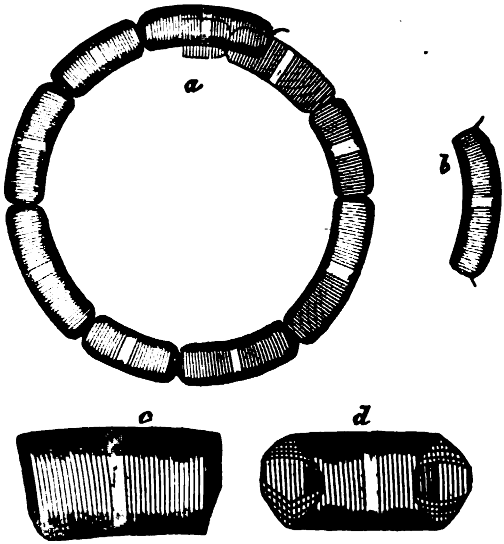
Since its discovery at Olton reservoir, *Leptodora* has been found in great abundance at Edgbaston Pool, another large sheet of water in the neighbourhood of Birmingham, and in both pools it was associated with *Hyalodaphnia Kahlbergensis*, also a new discovery in this country.

XXXIX.—*On a New Species of the Genus Eucampia.* By Henry Stolterfoth, M.D.

(*Read 8th October*, 1879.)

The genus *Eucampia* was defined by Ehrenberg, and placed by him amongst the Desmidiaceæ. In Smith's 'British Diatomaceæ,' vol. ii. p. 25, it is rightly placed amongst the Diatomaceæ. Only two species are recognized by Smith, *E. Zodiacus* and *E. Britannica*, and neither of these had been seen by him in the living state. Both these species I have taken living by means of the tow-net in the estuary of the Dee, Chester. There is another *Eucampia* known, in the Hong Kong gatherings made by Dr. Palmer, as *nodosa;* this latter is, I believe, identical with *E. Zodiacus*, and only represents a stronger growth in a hotter climate.

In the year 1875 my attention was called by A. O. Walker, Esq., Chester, to some circular rings taken in the tow-net. These were, however, very few, and I then took them to be some kind of unknown Confervæ. The rings I have since continually seen, but never in sufficient abundance to make out their silicious covering.



a.—*Eucampia striata* n. sp. × 350.
b.—A single frustule, showing spines.
c.—*Eucampia striata*, n. sp. var. *maxima*.
d.—The common appearance of the frustule when seen on a burnt slide.

On July 14th, 1879, I obtained a nearly pure gathering of this form and was able to make a careful examination of it both living, burnt on the cover glass, and preserved in fluid.

The definition of the genus *Eucampia* Ehr. as given in 'Sm. Brit. Diat.' vol. ii. p. 25, is—

"*Frustules* cuneate, quadrangular or oblong, united into a spiral filament; valves dotted, elliptical."

This definition slightly extended, so as to include my new form, obviates the necessity of creating a new genus:—

Frustules cuneate, quadrangular or oblong, united into a spiral filament; valves dotted or costate, elliptical or circular.

Eucampia striata n. sp. Breadth of the whole plant circle about ·01 of an inch. Valves hyaline. Side view, circular, ·002." Front view, trapezoidal, and about four or five times longer than broad. Marked with fine costæ extending across, 14 to the·001". A small spine at the angles terminating the convex border, and situated at the edge of the circular side view. Endochrome green.

Habitat, marine; estuary of the Dee, Chester, July 14th, 1879, and Hong Kong Harbour (Dr. Palmer).

In the same gathering I found another form, which I take to be a variety—*Eucampia striata* n. sp. var. *maxima*. I have never seen a complete circle of the whole plant, only five or six frustules together forming a curve. Valves hyaline. Side view, circular, ·004". Front view nearly square, marked with costæ 7 or 8 to the ·001". No spine. Endochrome green. In the dry state the ends of the valves fold over, as seen in *d*.

Habitat, marine; estuary of the Dee, Chester. July 14th, 1879, and Hong Kong Harbour (Dr. Palmer).

The variety *maxima* may only be a stage of growth, but it is constant in its appearance, and I do not find intermediate states of growth.

I have added the locality Hong Kong on the authority of my friend, Laurence Hardman, Esq., who pointed out to me the exact similarity between my form and that found in the Hong Kong gatherings, and which he believes has never yet been described owing to the want of fresh material.

XL.—*Immersion Stage Illuminator.*

By John Mayall, jun., F.R.M.S.

(*Read* 12*th November*, 1879.)

The illuminating device here described was obviously suggested by Professor Abbe's Apertometer disk.

It is evident that every apparatus fit for observing the aperture of a high-angled object-glass must likewise be capable of being used for illuminating the marginal zone of such an objective.

The apertometer-disk itself was found to require modifications as to size, shape, &c., to render it more practical as an illuminator, especially for lamp-light. The modifications here detailed have been designed specially with a view to using the illuminator on the Continental stands provided with concentric rotating stage, many of which do not conveniently admit the use of very obliquely incident light from beneath.

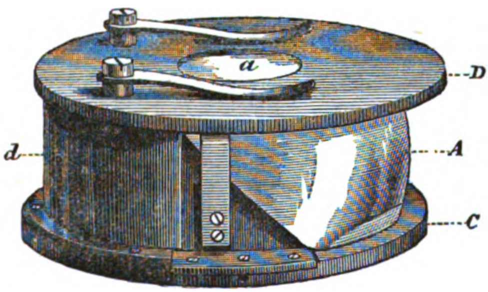


Diagram ¾ scale.

The plate of glass A is held on to the foot-plate C by means of vertical spring clips from which it can be removed for cleaning; the back edge is cut to an angle of 45° as in the apertometer-disk, for total reflection of illuminating rays; the peripheral margin, admitting the rays, is ground spherically instead of cylindrically, which adds to the illumination; it is supported by a brass semi-cylinder *d* which forms part of the foot-plate C. A brass object-plate D, carrying clips for the object-slide, is made to rotate on the upper surface of A round the circular glass plate *a* which is slightly below the surface of D and ground conical and cemented on to A and acts as a pivot to D, smooth rotation being obtained by means of a film of glycerine interposed.

The illuminator is to be secured firmly on the rotating stage by clamps on the projecting edges of the foot-plate after the centre of *a* has been centred with the optical system. The lamp and condensing lens to be suitably adjusted so that the reflected image

of the flame is seen nearly in the plane of the object. The object-slide is placed in immersion contact with the plate *a* under the clips; the brass plate D will now rotate the object-slide to the required position with reference to the incident light, while the rotation of the Microscope stage (carrying the illuminator) will give every range of obliquity from central light to dark-field with any objective, the lamp and condenser remaining stationary.

It would doubtless be possible to dispense with a rotatory stage by inserting the glass plate A into a rotating plate in the foot-plate C, but there would be difficulty in making the rotation exactly concentrical to the rotation of the brass object-plate D.

My acknowledgments are due to Professor Abbe for the interest he has shown in the practical development of the plan: without his assistance even this experimental device would probably not have been made.

XLI.—*On a Table of Numerical-Apertures, showing the Equivalent Angles of Aperture of Dry, Water Immersion, and Homogeneous Immersion Objectives, with their respective Resolving Powers, taking the Wave Length of Line E as the Basis; $a = n \sin. w$, n = refractive index, and $w = \frac{1}{2}$ angle of aperture.*

By J. W. Stephenson, F.R.A.S., Treas. R.M.S.

(*Read* 12*th Nov.*, 1879.)

As considerable misapprehension appears to exist, not only in this country but also in the United States, as to the special advantage of the "Numerical-Aperture" of Professor Abbe, I have thought it would be useful to construct the subjoined Table. It cannot be too strongly impressed upon microscopists, that the expression *angle of aperture* of objectives furnishes in itself no intelligible measure of the actual resolving powers, which, as will be seen by the Table, bear no relation whatever to the *angles*.

The resolving powers are, however, exactly proportional (*cæteris paribus*) to the *numerical apertures*, and the expressions for the latter will therefore allow the resolving powers of different objectives to be at once compared, not only if the medium (air, water, oil, &c.) is the same in each case, but also if it is different.

Thus, to say that a dry objective has an angle of 60°, a water-immersion 53°, and a homogeneous immersion 48°, conveys no idea (without calculation) of their relative resolving powers, but when we are told that the three objectives are of 0·50, 0·60, and 0·62 numerical aperture, the comparison is obvious.

The Table shows, moreover, how little increase in resolving power may be gained by a considerable increase in the angle. Thus two dry objectives whose angles are 180° and 157° respectively, differ in resolving power by only 2 per cent.

	Numerical Aperture $= a$.	Angle of Aperture in Air.	Water Angle.	Homogeneous (or Balsam) Angle.	Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0{\cdot}5269\,\mu$ = line E.)
Maximum aperture of homogeneous immersion objectives, with crown-glass cover ..	1·52	..	..	180° 0′	146,528
	1·50	..	..	161° 23′	144,600
	1·48	..	..	153° 39′	142,672
	1·46	..	..	147° 42′	140,744
	1·44	..	..	142° 40′	138,816
	1·42	..	..	138° 12′	136,888
Zeiss' homogeneous ⅛th (1879)	1·40	..	..	134° 10′	134,960
	1·38	..	..	130° 26′	133,032
	1·36	..	..	126° 57′	131,104
	1·34	..	..	123° 40′	129,176

	Numerical Aperture = a.	Angle of Aperture in Air.	Water Angle.	Homogeneous (or Balsam) Angle.	Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0 \cdot 5269\ \mu$ = line E.)
Maximum aperture of water-immersion objectives ..	**1·33**	..	180° 0′	122° 6′	128,212
	1·32	..	165° 56′	120° 33′	127,248
Powell and Lealand's homogeneous $\frac{1}{8}$	**1·30**	..	155° 38′	117° 34′	125,320
	1·28	..	148° 28′	114° 44′	123,392
Zeiss' homogeneous $\frac{1}{8}$, $\frac{1}{12}$, $\frac{1}{18}$ (1878)	**1·26**	..	142° 39′	111° 59′	121,464
	1·24	..	137° 36′	109° 20′	119,536
Powell and Lealand's ditto $\frac{1}{16}$	**1·22**	..	133° 4′	106° 45′	117,608
	1·20	..	128° 55′	104° 15′	115,680
Nobert's 19th band = 113,000	**1·18**	..	125° 3′	101° 50′	113,752
	1·16	..	121° 26′	99° 29′	111,824
	1·14	..	118° 00′	97° 11′	109,896
Powell and Lealand's water immersion $\frac{1}{8}$, $\frac{1}{16}$	**1·12**	..	114° 44′	94° 56′	107,968
	1·10	..	111° 36′	92° 43′	106,040
" " $\frac{1}{4}$ ..	**1·08**	..	108° 36′	90° 33′	104,112
	1·06	..	105° 42′	88° 26′	102,184
	1·04	..	102° 53′	86° 21′	100,256
	1·02	..	100° 10′	84° 18′	98,328
Maximum aperture of dry objectives	**1·0**	180° 0′	97° 31′	82° 17′	96,400
	0·98	157° 2′	94° 56′	80° 17′	94,472
Amphipleura pellucida = 92,000 to 95,000 ..	**0·96**	147° 29′	92° 24′	78° 20′	92,544
	0·94	140° 6′	89° 56′	76° 24′	90,616
	0·92	133° 51′	87° 32′	74° 30′	88,688
	0·90	128° 19′	85° 10′	72° 36′	86,760
	0·88	123° 17′	82° 51′	70° 44′	84,832
	0·86	118° 38′	80° 34′	68° 54′	82,904
Navicula crassinervis = 78,000 to 87,000 ..	**0·84**	114° 17′	78° 20′	67° 6′	80,976
	0·82	110° 10′	76° 8′	65° 18′	79,048
	0·80	106° 16′	73° 58′	63° 31′	77,120
	0·78	102° 31′	71° 49′	61° 45′	75,192
	0·76	98° 76′	69° 42′	60° 0′	73,264
	0·74	95° 28′	67° 36′	58° 16′	71,336
	0·72	92° 6′	65° 32′	56° 32′	69,408
Surirella gemma = 64,000 to 69,000	**0·70**	88° 51′	63° 31′	54° 50′	67,480
	0·68	85° 41′	61° 30′	53° 9′	65,552
	0·66	82° 36′	59° 30′	51° 28′	63,624
	0·64	79° 35′	57° 31′	49° 48′	61,696
	0·62	76° 38′	55° 34′	48° 9′	59,768
Pleurosigma fasciola = 55,000 to 58,000 ..	**0·60**	73° 44′	53° 38′	46° 30′	57,840
	0·58	70° 54′	51° 42′	44° 51′	55,912
	0·56	68° 6′	49° 48′	43° 14′	53,984
	0·54	65° 22′	47° 54′	41° 37′	52,056
	0·52	62° 40′	46° 2′	40° 0′	50,128
Pleurosigma angulatum = 44,000 to 49,000 ..	**0·50**	60° 0′	44° 10′	38° 24′	48,200
	0·48	57° 22′	42° 18′	36° 49′	46,272
	0·46	54° 46′	40° 28′	35° 14′	45,344
	0·44	52° 12′	38° 38′	33° 39′	42,416
	0·42	49° 40′	36° 49′	32° 5′	40,488
	0·40	47° 9′	35° 0′	30 31′	38,560
Pleurosigma Balticum = 33,000 to 37,000	**0·38**	44° 40′	33° 12′	28° 57′	36,632

Note.—The wave length assumed in the above Table is, as stated, $0 \cdot 5269\ \mu$, but it is not unimportant to observe, that if the

point taken had been, as nearly as may be, midway between E and F, i. e. $= 0 \cdot 508\,\mu$, the numerical aperture would *itself* have been the true measure of resolving power, being exactly equal to the number of hundred-thousands of lines in an inch; thus giving 100,000 lines as the maximum of a dry lens, 133,000 as that of a water-immersion, and 152,000 as the ideal maximum of a homogeneous-immersion objective with crown-glass covers.

As the resolution by the same objective is affected by the intensity of the illuminating beam, by the colour of the object, and other circumstances, it is not possible to assign an absolute measure —using the line D ($= 0 \cdot 5889\,\mu$), for instance, in the computation, the resolving power would be found to be $10\frac{1}{2}$ PER CENT. *less* than the tabular results: on the contrary, if the line F ($= 0 \cdot 4861\,\mu$) were selected, the resolving power would be $8 \cdot 4$ PER CENT. *greater*, or taking the line $= 0 \cdot 40\,\mu$ (near H_1), as probably sufficient for photographic resolution, the maximum number of lines which could be delineated by a dry lens would be 127,000, by a water immersion 163,910, or, by a homogeneous immersion objective (under present conditions) 193,040, although, if flint-glass covers with suitable homogeneous fluid were adopted, the ultimate limit might, on this hypothesis, be extended to, say, 200,000; and on the assumption that the space between each of these lines was equal to the lines themselves, it follows that the width of each line would be $\frac{1}{400{,}000}$ of an inch, but it by no means hence follows that this would be the ultimate photographic limit for a *single* line.

☞ There is *no loss of aperture on objects mounted in balsam*, or any more highly refractive medium (as was formerly supposed by many, myself included), under either of the systems, in fact the *full* resolving power (with transmitted light) can be attained only if the object is mounted in a medium whose refractive index is equal to, or greater than, the *numerical aperture* of the objective, so that if ever homogeneous objectives are constructed for flint-glass covers, some more highly refractive medium than balsam must be used for mounting the objects, such as bisulphide of carbon or oil of cassia.

XLII.—*Aperture Measurements of Immersion Objectives expressed as "Numerical Aperture."*

By John Mayall, jun., F.R.M.S.

(*Read* 12*th November*, 1879.)

As it is probable that apertures will be expressed, in future scientific discussions, by the nomenclature suggested by Professor E. Abbe, i. e. "Numerical Aperture," the following list of actual measurements may be interesting to microscopists :—

			"Numerical Aperture."
Zeiss's homogeneous immersion (Abbe's formula, 1879)		1/8	1·40
Tolles's oil immersion (1879)		1/15	1·30 +
" " "		1/10	1·30 +
" water immersion (1876)		1/12*	1·28 +
Zeiss's homogeneous immersion (1878)		1/18	1·25 +
Tolles's water immersion (1877)		1/10	1·20 +
Zeiss's homogeneous immersion (1878)		1/18	1·20 +
" " " "		1/8	1·20 +
" " " "		1/8	1·20 +
" " " "		1/8	1·20
" " " "		1/8	1·20
Tolles's water immersion (1875)		1/10	1·20
" " " (1876)		1/8	1·20
Powell and Lealand's oil immersion (1879)		1/8	1·20
Tolles's water "	(1874)	1/6	1·18
Powell and Lealand's " " new formula (1875)		1/6	1·18
Tolles's " "	(1874) belonging to Mr. Crisp	1/8	1·15 +
Powell and Lealand's " " new formula (1875)		1/8	1·15 +
" " " "	(1874)	1/16	1·15
" " " " new formula (1876)		1/8	1·15
Tolles's " "	(1876)	1/25	1·12
" " "	"	1/35	1·10
Powell and Lealand's " " new formula (1876)		1/8	1·10
Prazmowski's " "	(1874) No. 8 =	1/8	1·05 +
Zeiss's " "	(1875)	1/32	1·05 +
" " "	"	1/35	1·05 +
" " "	"	1/16	1·05 +
" " "	"	1/8	1·05
Nobert's " "	(1867)	1/26	1·00 +
Hartnack's " "	" No. 12 =	1/21	1·00 +
" " "	" No. 9 =	1/15	1·00 +
Prazmowski's " "	(1874)	1/35	1·00 +
Gündlach's " "	"	1/16	1·00 +

* I am indebted to Professor R. Keith (of U.S.A.) for this measurement. He measured the balsam angle to be 115° (the highest aperture attained at that date), which would be about 1·28 of "numerical aperture." The other measurements were made by myself, and several were verified by Professor E. Abbe.

					"Numerical Aperture."
Spencer's	water immersion	(1878)	.. ..	$\frac{1}{10}$	.. .. 1·00 +
"	" "	"	.. ..	$\frac{1}{8}$	.. .. 1·00 +
Ross's	" "	(1879)	.. ..	$\frac{1}{10}$	.. .. 1·00 +
Merz's	" "	(1868)	.. ..	$\frac{1}{18}$	slightly less than 1·00
"	" "	(1869)	.. ..	$\frac{1}{18}$	
Beck's	" "	(1875?)	.. ..	$\frac{1}{20}$	
Prazmowski's	" "	(1875)	.. ..	$\frac{1}{60}$	
Powell and Lealand's	water immersion	(1879)		$\frac{1}{50}$	

The above list does not include those immersion objectives, by various makers, which yielded measurements of balsam angle notably less than 82° (= 1·00 num. ap.). The signs + indicate in which direction the measurement tended.

RECORD

OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.,

including Embryology and Histology generally.

ZOOLOGY.

A. GENERAL, including Embryology and Histology of the Vertebrata.

Gestation of the Armadillo.*—Mr. Milne-Edwards refers to the presence of four fœtal (nine-banded) armadilloes in a common chorion; the phenomenon may, he thinks, be explained either (1) by a number of ovules having been enclosed in the Graafian follicle, inasmuch as these ovules might also be enclosed in a common granular layer, and this layer would, on accompanying them into the oviduct and thence into the uterus, be converted into a common chorion; or (2) the effect may have been produced by the disappearance of the granular layer of each ovule and by the subsequent investment of the four fecundated ovules by a layer formed by the walls of the oviduct or uterus;—but this could not happen unless the secondary (amniotic) chorion had been absorbed, or had never been formed; or, (3) the four amniotic chorions might have fused at their points of contact and have undergone absorption at all but their peripheral portions.

Vitality of the Spermatozoa of the Trout.†—The details of M. Henneguy's experiments will be seen by the following table, which shows the number of ova that became developed after they (having been impregnated), were subjected to the following agents:—

(1)	Pure water	62 eggs	50 developed.
(2)	Water with 5 per cent. alcohol	91 „	74 „
(3)	„ „ 10 „ „	59 „	50 „
(4)	„ „ 5 „ ether	51 „	42 „
(5)	„ saturated with chloroform	32 „	19 „

The fishes produced exhibited no difference to those developed from ova which had been fecundated in the ordinary manner; and it is concluded that doses of alcohol, &c., which are sufficient to kill Infusoria for instance, have no effect on the spermatozoa.

Experiments on Development.‡—MM. Pouchet and Beauregard describe some experiments in which they removed from eggs a small quantity of their liquid albumen and replaced it by a certain quantity (half a gramme) of sugar; and then reclosed the eggs in the manner they have already described. Experiments were made on eighty eggs, and of these twenty-eight were opened during the first thirteen

* 'Comptes Rendus,' lxxxviii. (1879) No. 9.
† 'CR. Soc. Biol.' for 1877 (1879), p. 274.
‡ Ibid., p. 338.

days of incubation; fifteen were found to be undergoing the normal processes of development, and thirteen, though partly developed, were found to be dead. No observations were made on eggs more than thirteen days old; in no case did the cane-sugar seem to have been converted into glucose, but the authors are unable to reply to the question they themselves propose: Has the sugar remained unaltered in the albumen or has it been absorbed by the embryo? They draw, however, attention to what they were enabled to observe in those eggs which underwent no development at all; part of the vitellus presented a milky-white colour, the albumen, especially near the yolk, was opaque, and the egg, when opened, had the odour of a substance in which lactic fermentation was going on.

M. Pouchet has also made some experiments on the eggs of birds, with the view of seeing whether the form of the egg has any influence on the direction in which the embryo is developed, and found that if he seized a chalaza and turned it round in the yolk, and then allowed development to proceed, the embryo was itself altered in position.

Granular Bodies found in the Ovum.*—M. Dareste reaffirms the presence of amyloid granules in the yellow of the egg; he shows the presence of starch by the action of chemical reagents, and points out that the fact of these granules not being composed of lecithin is shown by their insolubility in alcohol or ether; he has not, however, been able to isolate these granules from the rest of the mass.

M. Dastre, however, is of opinion that the granulations are phosphates of fatty bodies (of lecithin), and asserts that they contain no starch; he draws attention to the difficulty of finding starch, which gives a blue reaction to the iodine test (as found by Dareste), and points out that it is only vegetable starch which does this, and that animal starch reddens under the action of iodine.

Development of the Ova and the Structure of the Ovary in Man and other Mammalia.†—The history of these structures has been lately dealt with by Mr. Balfour in the 'Quarterly Journal of Microscopical Science,'‡ and to this paper Dr. Foulis refers in one by himself in Humphry's 'Journal of Anatomy and Physiology.'

The principal results arrived at by Dr. Foulis are that all the ova are derived from the germ epithelial cells. In the development of the ovary small and large groups of the germ epithelial cells become gradually embedded in the ever-advancing stroma. Germ epithelial cells do not grow downwards into the substance of the ovary. The ovarian stroma constantly grows outwards, surrounding and embedding certain of the germ epithelial cells. As these latter increase in size, and as the stroma thickens around them, the whole ovary becomes enlarged. Pflüger's tubes in the kitten's ovary have no existence as such, but are appearances produced by long groups

* 'Comptes Rendus,' lxxxviii. (1879) Nos. 11 and 14; see 'Rev. Sci. Nat.,' i. (1879) p. 91.

† 'Journ. Anat. and Phys.' (Humphry), xiii. (1879) p. 353.

‡ 'Quart. Journ. Micr. Sci.,' xviii. (1878).

of embedded germ epithelial cells, many of which groups are not completely cut off from the germ epithelial layer by the young ovarian stroma. Such groups of germ epithelial cells, in various forms, are met with in all ovaries, but have no importance whatever as tubular structures. In the human child's ovary numerous furrows, or clefts between irregularities of the general surface, are met with. Sections through these furrows and clefts produce the appearance of the germ epithelium (pseudo-epithelium, Balfour) having passed downwards into the ovary in the form of tubular open pits, as was described by Waldeyer and his predecessors. No real tubular structures from which Graafian follicles are formed exist in the mammalian ovary at any stage of its development. Graafian follicles are formed only in one way from the beginning of the ovary to the end of its existence.

The youngest connective tissue of the stroma, in the form of offshoots of jelly-like protoplasm, surrounds and embeds large and small groups of germ epithelial cells. A single germ epithelial cell may be completely surrounded by this young connective tissue. When this takes place the germ epithelial cell rapidly grows and becomes a primordial ovum. Each individual cell in a group of epithelial cells, surrounded by the young ovarian stroma, shows a similar tendency to become a primordial ovum. All the groups of developing germ-cells or cell-nests in the ovary are broken up into still smaller cell-nests by the ever advancing young connective tissue, until, at last, individual cells in the cell-nests become completely surrounded by the youngest connective tissue. When an individual germ-cell becomes surrounded by the young connective tissue, at the same time, and as part of the process, the Graafian follicle begins to be formed. Whenever the young jelly-like connective tissue appears, in its substance nuclei, generally fusiform at first, make their appearance. These nuclei may be always seen in contact with the yolk substances of the primordial ova. The follicle cells are derived from the nuclei which lie in contact with the protoplasm or yolk substance of the developing ova. This takes place in all parts of the ovary wherever cell-nests are formed. The follicle cells thus originate from the cells of the ovarian stroma, and not from the germ epithelial cells. In the mammalian ovary at birth the most advanced ova are met with deep in the ovary, and not in passing from without inwards, as described by some observers. In a ripe Graafian follicle the stroma cells outside the membrana propria folliculi become converted into cells exactly similar to the true follicle cells, and it is possible to trace the ordinary stroma cells outside the follicle through all stages of development into cells resembling the follicle cells, the observation affording a most conclusive proof of the origin of the follicle cells from the ordinary cells of the stroma.

With these results it will be interesting to compare those of Mr. Balfour; he, likewise, says "The whole egg-containing part of the ovary is really the thickened germinal epithelium." "Pflüger's egg-tubes are merely trabeculæ of germinal epithelium, and have no such importance as has been attributed to them." So again, as

regards the "cell-nests," Mr. Balfour observes that he noted "the fusion of several ova into a syncytium, the subsequent increase in the number of nuclei in the syncytium, the atrophy and absorption of a portion of the nuclei, and the development of the remainder into the germinal vesicles of ova."

Micro-chemical Researches on Cell-nuclei.*—Dr. Brandt has been making some observations, from a micro-chemical point of view, on cytods and cells. The researches of Miescher have shown that the cell-nucleus consists of a special substance, nuclein, which is distinguished by the possession of phosphorus. Brandt treated some *Protamœbæ* with ten per cent. salt solution, and found that they broke up altogether; where nuclein is present a precipitate is left, and this, which was found where Protozoa proper (that is, nucleated forms, and not Protista or cytod forms) were acted on by the reagent, is regarded by Brandt as being a carbo-hydrate allied to cellulose. We have here therefore a valuable method to be applied in all cases where the presence of a nucleus is disputed.

Observations on the Living Cartilage Cell.†—W. Schleicher, whose paper on the division of cartilage cells has been already noticed,‡ now investigates more fully the movements observed in these cells and in their nuclei.

The nucleus moves as a whole, vibrating (*ballotter*) from side to side, either quite irregularly, or, if it is in contact with the edge of the cell, regularly from right to left, and *vice versâ*. The action is caused by the solid elements in the protoplasm of the cell, which are in constant vibration, communicating the movement to the nucleus. The slight changes in form undergone by the surface of the latter are due to the same cause. The solid elements within the nucleus (rods, filaments, &c.), are, like those of the cell itself, in constant motion, by virtue of which they cause slight changes of form in the nucleus, which, from being spherical, may present slight tuberosities. The movements may be augmented in intensity by raising the temperature to 20°–25° C.

Schleicher objects to the term "reticular" as applied to the refractile elements of the nucleus. He says that just as the cell-protoplasm is composed of two different substances, an almost liquid and homogeneous matrix, and solid contractile elements, floating freely in this liquid, so the nucleus consists of a nuclear fluid, and of solid contractile elements like those of the cell-body, but separated from them in the quiescent state of the cell by the nuclear membrane.

Microcytes (very small Red Blood-corpuscles) in the Blood.§—MM. Lepine and Germont state that in the blood of a patient suffering from carcinoma of the stomach, they observed a considerable proportion of globules varying in diameter from 2 to 5-1000ths of a mm. These bodies were spherical and by no means biconcave, but their coloration was so slight that it was with some difficulty that they

* 'Zeitschr. gesammt. Naturwiss.' (Giebel), lii. (1879) p. 120.
† 'Bull. Acad. Roy. Sci. Belg.,' xlvii. (1879) p. 811.
‡ This Journal, *ante*, p. 273.
§ 'CR. Soc. Biol.' for 1877 (1879), p. 164.

were observed to be red; these globules or microcytes were observed on *only one occasion*, and after their appearance the patient in whom they were found, exhibited a considerable, though unfortunately only temporary, improvement.

Two hypotheses present themselves in explanation of the phenomena: either the microcytes owed their origin to the secondary formation of a number of new red corpuscles, which would require a certain time to attain the normal size, or they were due to the breaking up of a number of red corpuscles. The former hypothesis is supported by the explanation offered by several histologists as to the presence of the small red corpuscles which measure from 6 to 6·5 micromillimetres in diameter; while the second, which seems to be the more satisfactory, would be supported by the cachectic state in which the patient was found previous to their appearance, and by the *à priori* supposition that it is more natural to regard them as fragments of corpuscles, which have only become spherical owing to the action of the fluid blood. The authors point out that the best way to solve the question is to apply the colorimetric test and to discover whether the amount of hæmoglobin is increased, in which case the former hypothesis would be shown to be the correct one, or whether the hæmoglobin is not increased in quantity, in which case the presumption would be in favour of the second, and they promise to perform experiments in this direction.

Terminal Nerve-plexus in the Cornea.*—M. Ranvier, in an introduction to an account of some experiments on the function of this plexus, points out that in the rabbit the largest nerves are the deepest, and the smallest the most superficial; that they all divide and subdivide dichotomously; that they take a course towards the surface, where they unite to form a large plexus.

The results of his experiments go to show that (1) The view of Snellen, in which the presence of trophic nerves in the cornea was denied, is correct, inasmuch as nutrition is still regularly effected after all the nerves which supply this region, are cut; (2) The nerve-filaments pass very rapidly into the plexus and always retain their physiological and anatomical individuality—in other words they merely form a *plexus* and not a *network*; (3) This plexiform arrangement of the nerves of the cornea does not seem to have any special physiological duty, but to be due to the necessity of an arrangement which shall not disturb the homogeneous character of the membrane; (4) The nerves have only a general sensibility, and yet their presence is not absolutely necessary; it is "une fonction de luxe," inasmuch as the insensitive cornea may be well protected by the sensitive conjunctiva and eyelids.

Harderian Gland of the Duck.†—Dr. Jules MacLeod in a paper on the histology of this gland says that it is a compound tubular gland, being made up of glandular tubules disposed in a verticillate manner around common canals, so as to form secondary tubules.

* 'Comptes Rendus,' lxxxviii. (1879) p. 1087.
† 'Bull. Acad. Roy. Sci. Belgique,' xlvii. (1879) p. 797.

The form of the primary, and the disposition of the secondary tubules, allows of the division of the organ into two parts; a superior, in which the primary tubules are contorted, the secondary few and incompletely separated; and an inferior, in which the primary tubules are straight, the secondary numerous and completely separated by septa.

In the primary tubule, two regions may be distinguished, differing according to the character of the glandular cells.

The Harderian gland of birds resembles in structure that of reptiles, but differs wholly from that of mammals, which is a racemose gland.

There are certain glands which form a transition between the gland in question and the simple tubular gland on the one hand, and the racemose gland on the other.

Structure of the "Eye-spots" of some Osseous Fishes.*—Dr. M. Ussow points out that the structure of these organs, the presence of which has been noted by a number of zoologists, has never been investigated by any anatomist other than Leuckart (1864); the author himself has already published some observations on the subject, in which he has demonstrated the metameric character of these organs, and has shown that they are formed on the type of the so-called compound eye, and are provided with simple corneæ. The structures may be arranged in two series; in one they are accessory eyes, and in the other they form pigmented glands; the genera *Chauliodus*, *Astronesthes*, and *Stomias* present examples of the former, as do *Scopelus*, *Gonostoma*, and *Maurolicus* of the latter. The organs in question are found on either side of the ventral median line, where they form one or two parallel rows extending from the caudal fin to the first ray of the thoracic fin; they are placed just below the scales, and they have the form of small pigmented spots, varying in number from sixteen to forty-eight.

After describing in detail their character and position in a number of forms, Dr. Ussow passes to an account of their structure. Most simple in *Astronesthes*, they have the form of a biconvex lens, which projects somewhat beyond the surface of the body, and they exhibit the following points: (1) a thin investment of connective tissue which completely envelopes the eye; (2) a thicker pigment layer, formed by six-sided dark brown cells; (3) in this there is a circular orifice, which is merely covered by the transparent envelope; then (4) there is a lens-shaped body which resembles in structure the lens of many Vertebrata; (5) in the subjacent layer we find transparent hexagonal plates, altogether devoid of pigment, not exhibiting nuclei, but showing a longitudinal striation of their component protoplasm. These cells are arranged concentrically, and the whole of the internal cavity is filled with a transparent watery fluid, which easily coagulates under the influence of reagents. The organs in question appear to be supplied by the rami ventrales, which send fine nerve-filaments to them. We have no space to follow the

* 'Bull. Soc. Imp. Nat. Moscou,' liv. (1879) p. 79.

author into his accounts of the eye-spots of *Stomias* and *Chauliodus*, which appear to be formed on the same type.

In *Gonostoma*, *Maurolicus*, and *Argyropelecus*, the structure is altogether different; they have distinctly the character of glandular organs. Taking for description the first-named of these genera, we find that the form of the organs is oval, and that they consist of a number of radially arranged cones, the tips of which point to a central cavity; each constituent cone is ordinarily sharply separated from the rest by a thin investment derived from the general investing capsule; in their more intimate structure they consist of a number of pyriform cells, set concentrically around a central cavity, and there are also two other envelopes, one of which is pigmented, while the other consists of connective tissue; the pigmented layer is of a dark-brown colour, and resembles generally the pigmented layer found in *Chauliodus;* the characters of this form, as well as the general structure and regular disposition of the parts under discussion, point, in Ussow's opinion, to the common origin of these glands and of the eyes found in the other sets of forms. As before, we must refer our readers to the original for a description of the similar organs in the other genera above mentioned.

In dealing with the morphology of these organs, the author commences by pointing out that the arrangements seen in such Invertebrata as *Mysis* and *Polyophthalmus* prevent our associating the special organs of sense with the region of the cerebral ganglia only, and he then insists on the value which the position of the eyes in the Asterida and various Myriapods and Rotatoria has, as compared with the eye-like organs of these fishes; as may be supposed, therefore, the structures just described are regarded by the Russian investigator as proper accessory optic organs; as to the gland-like organs of the second series, he points out that no orifice can be observed in them, and he compares them with those special end-organs which are to be found in so many fishes. In conclusion, it is to be noted that the metameric or segmental arrangement of these parts is a point of considerable importance.

Two tables and four plates illustrate the details of the paper.

Histology of the Cerebellum of Petromyzon fluviatilis.*—The cerebellum of *Petromyzon*, which, in most of its morphological characters, resembles that of the frog, has been lately subjected to a histological examination by A. Jeleneff. Forming a vertical interposition between the cerebral hemispheres and the medulla oblongata, it is nothing more than a thin plate, and is only separated from the former by a small pit, while the *corpora geminata* of the frog are not developed in this fish. The necessary process of hardening the cerebellum was effected in the following way; it was first placed for from seven to nine days in a solution of bichromate of potash, and was then exposed for four days to a one or two per cent. solution of chromic acid. After careful washing with distilled water, it was placed in alcohol of 60°; the preparations were stained with carmine,

* 'Bull. Acad. Imp. St. Pétersbourg,' xxv. (1879) p. 334.

eosin, or a weak solution of hæmatoxylin; and, in some cases, with chloride of gold.

The cerebellum of the Vertebrata is ordinarily regarded as consisting of four layers—fibrous, nuclear, cellular, and molecular. In *Petromyzon*, however, only three layers were found, inasmuch as the fibrous layer is not distinctly developed. Lining the fourth ventricle is an investment of epithelial cells, which have the general characters of cylinder-epithelium; their free surface is flattened, while their sides form a cone which projects some way inwards, but does not seem to be connected with the nervous elements; towards the upper surface, these epithelial cells become flattened and altogether lose their characteristic form. Below the epithelium there is a layer of nerve-fibres with small rounded cells, which are so closely packed that the fibres are with difficulty detected; it is in consequence of this arrangement that it is impossible to assert the presence of a fibrous, distinct from the nucleated, layer. The nerve-fibres ordinarily run parallel to the surface, and a few only pass into the mass of the cerebellum to become connected with the processes of the deeper lying cells. The author does not find himself able to support the view of Golgi that the fibres come into connection with the peripheral ganglionic cells. Three sets of fibres were distinguished: (1) medullary nerve-fibres; (2) non-medullated fibres; and (3) fibres, in which the axis-cylinder was only partially covered by medullary substance.

The nuclear-substance is composed of cells, which are rounded in form, and have in the centre a highly refractive portion; the view of V. Baer, that they are arranged in groups rather than, as Denissenko states, in regular rows, is stated to be the more correct; the so-called "nuclei" give off fine processes, which enter into various connections; but much of what follows is concerned with a criticism of Denissenko's statements, into which it is impossible for us to enter. In the midst of the cells there are to be found a number of nerve-fibres, which surround the cells and are partly connected with them by processes, and the connection is so close that the author is inclined to speak of a nucleo-fibrous layer.

As to the cellular layer, the only differences between *Petromyzon* and the frog lie in quantitative characters; there is a series of large pyriform cells—the cells of Purkinje, which are provided with two processes, and have their greater portion occupied by a large nucleus; these cells are invested by a membrane of a character somewhat difficult to distinguish in its continuations on to the processes of the cell; the plasma surrounding the nucleus is traversed by primitive fibrillæ, which are collected together at the process into which they pass.

The "molecular layer" is almost completely made up of the branches of the peripheral processes of the cells of Purkinje, and these cells though they vary greatly in direction never pass into the nerve-fibres.

Spinal Ganglia and Dorsal Medulla of Petromyzon.*—An account of his examination of these structures is given by Herr Freud.

* 'SB. Akad. Wien,' lxxviii. (1879) p. 81.

The difficulty of the investigation was enhanced by the smallness of the spinal ganglia; making use of fresh specimens, which were separated into small pieces in consequence of the fact that gold chloride does not infiltrate through any great depth of tissue, and choosing especially the caudal end where the muscular layer is thin, and the mass of fatty cells feebly developed, or carefully separating off the muscular portions, or, still better, by removing the nervous portions by dissection of the animal, the author placed them in solutions of gold chloride ½ per cent. or ¼ per cent. strong; 1 per cent. solutions were also used, but the best results were obtained with the ¼ per cent. solution. Thence the specimens were removed to Pritchard's reducing fluid, formed of one part of formic acid with one of amyl-alcohol and 100 of water, where they remained for twenty-four hours exposed to the light. The preparation, which would be now of a dark purple-red colour, was removed to Königstein's macerating fluid, containing 50 parts fuming hydrochloric acid and 35 parts water and 15 parts glycerine. Twenty-four hours' maceration made the preparation much darker and separated it into small pieces; removed to glycerine to be rendered transparent, these were, after twenty-four hours, fit for inspection.

Dealing with the "essential" characters in the structure of the spinal ganglia, Herr Freud points out that the cells of these structures become arranged in two distinct layers, of which one belongs to the dorsal and one to the ventral branch, and it is in the latter that we find a smaller number of larger cells as a general rule. Varying in arrangement and in compactness as they appear to do at first sight, we soon learn that the spinal ganglia always present certain types, and that these types reappear at definite points, so that the spinal ganglion of a certain segment has the same "physiognomy" in all animals. There are but two essential elements in a spinal ganglion—nerve-cells and nerve-fibres; the former vary in number from eight to twenty-three, but from ten to sixteen is the most common number; they are of three sizes, but the medium forms are the most usual; their form is spherical or ellipsoidal, and their contours are well marked; they are, with scarcely an exception, bipolar, for those which are ordinarily regarded as unipolar are merely modifications of the others. It is interesting to compare this observation with that of Dr. Beale, whose knowledge of this subject is probably unequalled—"There are no apolar cells and no unipolar cells in any part of any nervous system."

The author deals in detail with the fibres of the ganglion, which are found to vary greatly in size, and passes on to "Details of the Structure of the Spinal Ganglia," "Remarks on the Relation of the Spinal Ganglia to the Dorsal Medulla," "On the Origin of the Roots of the Nerves and on the Dorsal Medulla and pia mater." The paper, which is illustrated by four plates, extends over eighty pages.

Amœboid Epithelia.* — Professor Graber, of Czernowitz, adds another to the list of cases in which amœboid movements have been

* 'Zool. Anzeiger,' ii. (1879) p. 277.

observed in the cells of the higher animals. He finds that the blastoderm cells in *Chironomus* send out well-marked pseudopodia (some straight, some bent, others branched) into the space between the egg and its membrane. They are best seen at the upper pole of the egg, opposite the polar cells. Their movements are often so rapid as to be with difficulty figured with the camera lucida. Sometimes, too, cells of the blastoderm become detached, and form true wandering cells, but probably these are subsequently reabsorbed.

Effects of Induced Currents on the Nervous System.* — The contribution of M. Schiff on this subject opens up quite a new field of physiological research, which promises to be of extreme importance. He was led to undertake his experiments by having observed the results of M. Charcot's researches on hysteric patients. This eminent physician has demonstrated that on the application of metallic plates to the extremities of hysteric persons, in whom one side of the body appeared more or less completely insensible, sensibility was in a few minutes entirely restored, for a time; during the operation the opposite side was completely insensible, so that it is clear that we have not to do with any *general augmentation* of the faculties of the organism; with a magnet similar results can be obtained when it is held at the distance of one or two centimetres from the patient, but in this case the results are more remarkable, inasmuch as it is, of course, possible to affect the patient with the magnet, while he remains totally ignorant of its nearness to him.

Led by these experiments M. Schiff has lately devoted himself to a series of researches on animals by the aid of an induction coil; the object in view has been to see whether these agents can modify the functions of the nervous system, and if they can, by producing hysterical conditions, reveal to us some method by which these phenomena can be analyzed; the following are brief indications of some of the results:—

(1) When the skin of the leg of a frog was touched by the terminations of rheophores connected with a very feeble battery the sensibility of the digits to contact was augmented; this augmentation, which was tested by the reflex movements of a pithed frog, was not exhibited until after a latent period of from eight to twenty-five minutes.

(2) Similar results were obtained with motor nerves.

(3) The modifications in the functions of the nerves were expressed by modifications in their electrical properties; thus, if the lower portion of the extremity of a frog was submitted for twenty minutes to a feeble induced current, no electric current was to be observed in the sciatic nerve itself.

(4) When the sciatic nerve was placed between the two poles of a very powerful electro-magnet, the latent period which always intervenes between the moment of irritating the sciatic plexus and the contraction of the gastrocnemius muscle was slightly increased.

A series of experiments was also made on dogs, with a view to see what were the effects on the *nerve-centres* of magnetic stimulation.

* 'Arch. Sci. Phys. et Nat.,' i. (1879) p. 226.

Schiff's late experiments on the so-called motor centres of the brain have led him to believe that it is possible to destroy or to weaken the tactile sensations or the sensations of pressure and of pain by effecting a lesion of the cerebral substance; what happens when, after such an experiment, an extremity has its superior portion brought under the influence of the magnetic coil? When the circuit remains open the effect is *nil*, but when the circuit is closed then there is seen a very evident increase in the sensibility of the parts, without, however, any consciousness; the reflex activity is merely more energetic in some portion of the centre which lies inferiorly to that in which stimulation of nerve-centres leads to consciousness. The paper concludes with the following observation:—In hysterical patients, and in the case of those who are suffering from certain other cerebral affections, there is not, so far as any evidence shows, any organ wanting; at the same time we may admit that there is in them a greater resistance than ordinary to the transmission of stimuli to the centre. When the impulse becomes greater it may overcome the resistance and force a transmission of the stimulus. In the dogs experimented on this "forced transmission" may obtain also, but in them it has no effect, inasmuch as it is stopped by the cicatrix of the previously effected lesion.

M. Schiff promises to continue his observations on the effect of magnetization.

Mollusca.

Habits of the Octopus.*—This creature, M. Frédéricq tells us, lives alone under large stones, in a kind of hole, the entrance to which is paved with smaller pieces of rock. Its habit of casting all around its retreat what it has left of its repasts betrays its habitation, so that when we meet with scattered fragments of crustacean carapaces and molluscan shells, still retaining their ligament, we may be almost certain that an octopus is near. When its home has been discovered it must be withdrawn from it by force; at the moment it is seized it often emits an inky stream of water, but there is not much danger of being bitten; M. Frédéricq in all his experience having been only bitten once, and then quite slightly. If they are well supplied with water and placed in a sufficiently large aquarium they retain perfect health; they do not seem to mind captivity, and do not attempt to escape.

Segmentation of the Ovum in Helix aspersa.†—Professor Perez points out that a large number of observers have agreed with Semper in stating that the follicles of the hermaphrodite gland, previous to the period of functional activity, are clothed with a "vibratile epithelium," of which some cells become, later on, converted into ova and others into spermatic cells, and he further shows that Ludwig has correlated the contradictory statements as to the presence or absence of a vitelline membrane, by pointing out that there are in various Pulmonate Gasteropoda all degrees of transition between a superficial

* 'Arch. Zool. Expér.' (Lacaze-Duthiers), vii. (1878) p. 536.
† 'Journ. Anat. et Phys.' (Robin), xv. (1879) p. 329.

and merely condensed layer and a distinct membrane. *Helix aspersa* was always observed to be provided with a true membrane by M. Perez; it is seen most easily in the earlier stages, when it is easily distended by water; in the mature egg, however, it is difficult to demonstrate its presence, but observations of different ova will probably satisfy the observer as to its existence.

Turning to the next succeeding phenomena, Perez states that the first sign is a series of changes in the germinal spot, and the subsequent appearance of two small nucleoli; these changes consist in the appearance of pale and indistinctly separated granulations, in the midst of which two small nucleoli may be seen; the germinal vesicle loses its distinct contour and its membrane folds in just like a bladder does when its contents are being expressed; suddenly it disappears and leaves no trace of its existence.

The clear space thus left is rapidly surrounded by yolk-spheres and two "centres of attraction" dominate over the substance; in other words, the two nucleoli are developed at the expense of the substance of the germinal spot. As to the connecting "fusiform body," it is supposed that it has nothing in common with a modified nucleus, but that it is due to purely physical causes, which compel the connecting lines of molecules to form arcs between the two nucleolar centres. Experiments by the aid of pressure led the author to the conclusion that the two nucleoli of the germinal spot, rendered free by the dissolution of the nucleus, become surrounded by rays in consequence of the attraction which they exercise on the surrounding protoplasm.

As to the "polar globule," the author gives the following account, which is of extreme interest. In his view what happens is this: when the nucleoli have attained a certain size, they become provided with a membrane, the presence of which is the cause of the cessation of the movements of molecules around the nucleolus; the fluidity of the substance which has undergone cohesion increases as the attractive power of the nucleoli disappears; and the fusiform system tends towards disaggregation; on the other side there is the vitelline mass, which exerts a certain amount of contraction on the system, which is thereby forced towards the surface of the egg, from which it is finally expressed in a spherical form in consequence of the forces exerted by the molecules of the fluid. The fusiform radiating substance is expressed in two drops.

There now remain the two nucleoli (nuclei) without any fusiform connecting mass. They increase greatly in size, and their proper nucleoli are continually subdivided, until at last they form mere granulations; the succeeding stages the author has not been able to observe, but he is not inclined to think that they become fused, but that, rather, one is totally destroyed while the other, persisting, develops two nucleoli, which become the centres of a new system of radially arranged molecules, and which, by affecting the whole of the vitelline mass, effect its segmentation. He points out that the presence of the two primary nuclei (after the formation of the polar bodies), both of which have had a common origin, is an excellent argument against regarding one of them as being a spermatic nucleus;

and he congratulates himself on having shown the direct descent of the nucleus of segmentation from the germinal spot. Although the germinal vesicle disappears the spot gives rise directly to two new nucleoli; and the theory of Haeckel, which requires the presence of, at some stage, a cytod, or non-nucleated cell (ovum), must be consequently modified. Earlier observers have, however, stated that the ovum is always nucleated; and it is to be hoped therefore that some observer will, as M. Perez suggests, submit his observations to an "infallible criterion"—the examination of ova which are developed parthenogenetically.

Cutaneous Absorption of Helix pomatia.* —M. Mer has made some experiments on the curious faculty possessed by the snail of absorbing a large quantity of water; first noted by Spallanzani, it was cited by the eminent physicist Dutrochet as a remarkable example of the power of osmotic forces.

1. A *Helix pomatia*, entirely immersed in water, absorbed it not only by its integument, but also by the walls of its pulmonary sac and of its digestive tube. If a healthy example is under observation, the experiment may be continued for three days, but the quantity absorbed, though exceeding in weight the snail itself, is not taken in regularly; absorption, very rapid at first, continually decreases, though without altogether ceasing, until the moment of death.

2. So too with regard to the expulsion of the absorbed water; when the animal is removed to air, the water is at first got rid of with great rapidity, and the excretion becomes gradually less.

3. The period of excretion is longer than that of absorption, but even then all that has been absorbed is not excreted, owing to the fact that, previous to the experiment, the tissues of the animal did not contain all the water which they were capable of holding.

4. In correlation with this it is to be observed that if a snail is removed from the water after a period of immersion lasting only for two or three hours, it takes a considerable time to rid itself of the fluid which it has so rapidly absorbed.

5. The amount of water absorbed depends on the state of contraction of the muscles around the blood sinuses.

6. If left in water after death, the tissues free themselves from the liquid.

7. The penetration of water appears to have no effect on the constituent elements of the body, and death appears to be due to the resistance offered by the water to the active circulation of the blood.

8. Although all parts of the body are able to absorb water, the walls of the pulmonary sac appear to be most capable.

Treated with such colouring agents as carmine, aniline blue, or rosaniline, the snail exhibits, with weak solutions, no other phenomena than those observed with water; but it is to be observed that the colouring matters did not, in any appreciable quantity at any rate, pass into the blood. Experiments with stronger solutions are described in detail, and the author comes finally to the consideration of the question, Is the penetration of fluids effected by passages

* 'CR. Soc. Biol.' for 1877 (1879), p. 186.

between the epithelial cells, or does the fluid penetrate the cells themselves? The second method seems to be that adopted, inasmuch as (1) the canals are present in certain aquatic molluscs, e. g. *Cyclas cornea*, which do not swell up in water; (2) colouring matters have been observed in the cells themselves; (3) the phenomena appear to be rather those of dialysis than of endosmosis; and (4) the epithelial cells have a great affinity for water.

Influence of "Cardiac Poisons" on Helix pomatia.* — The experiments of Hæckel on the effects of strychnine on the *Gasteropoda* have led M. Vulpian to repeat some experiments, which he described in his course of lectures of 1864, when he showed that *Upas antiar*, which acts so freely on the heart of the frog, has no such influence on the heart of the mollusc. Dealing with an alcoholic extract of *inée* (*Strophanthus hispidus* DC.), which has, on the frog, the effect of stopping the ventricle in the systole, and the auricles in the diastole, he finds very similar results with the *Helix*. As the effect of the injection of the poison there is a cessation of locomotor movements on the part of the animal, the movements of the heart become irregular, and there appear periods of arrest in its activity; at the end of two or three minutes the auricle is found to be distended, while the ventricle is very markedly contracted. When the heart has a drop of the solution placed on it, the results are very far less marked. A solution of muscarin was found to be much more feeble, the movements of the heart became much slower, and occasionally ceased, but the arrest never continued for more than five or six minutes; atropine was found to have an antagonistic effect; and, in fine, with regard to these two poisons, their influence is very much the same on the snail as on the frog; and from this M. Vulpian infers that there is a certain analogy between the innervation of the hearts of the snail, the frog, and the mammal. Neither muscarin nor *inée* seem to have any influence on the heart of the crayfish.

Respiratory Apparatus of Ampullaria.†—M. A. Sabatier, referring to M. Jourdan's description ‡ of the double respiratory apparatus of the *Ampullariæ*, consisting both of a branchia and a lung, says that he is able to give some new facts which had previously escaped observation.

The venous blood, returning from the different parts of the body, divides into three parts:—one passes to the right into a cavernous sinus, which accompanies the terminal intestine; this is the *rectal sinus*, which is a diverticulum of the general cavity of the body; the second comes from the anterior region of the body (head, pharynx, stomach, anterior margin of the palatine arch) and forms on the right the *proper afferent vessel* of the lung, which it circumscribes to the left and in front; this vessel presents a double series of orifices for the afferent branches of the roof and of the floor of the pulmonary chamber; the third part, which is far more important, comes together

* 'Comptes Rendus,' lxxxviii. (1879) p. 1293.
† Ibid., p. 1325; 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 323.
‡ This Journal, *ante*, p. 706.

in a large deep vessel with muscular walls, which soon ramifies on the lower surface and on the thickness of the large gland, already alluded to. From this network the efferent vessels take their origin, the greater part of which reunite in a large trunk with muscular walls which carries the blood to the renal organ: this is the *deep afferent vessel of the renal organ*, peculiar to the *Ampullariæ*. The other vessels which originate from the large gland discharge themselves successively into a superficial vessel of no great size, placed on the posterior margin of the renal organ, and which is its *superficial afferent vessel*, corresponding in all respects to the single afferent vessel of the other Pectinibranchiata. Hence the blood which has traversed the large gland in a true portal system is not, as M. Jourdan thinks, mingled with the blood returning from the organs of respiration, to be immediately poured into the heart, but it does not reach the latter until after it has traversed the renal organ first and the respiratory organs afterwards.

From the anterior margin of the renal organ there originates, by successive roots, an efferent vessel of the renal organ, which, after having anastomosed with the afferent vessel of the same organ, continues forward on the right margin of the principal branchia, of which it constitutes the afferent vessel. This vessel receives, in passing, some affluents from the rectal sinus.

On the left margin of the branchia, between the latter and the lung, is a large trunk which terminates at the auricle, and which is not simply, as M. Jourdan thinks, an efferent vessel of the branchia and of the lung. This vessel contains, in fact, a series of fissure-like orifices, which pour into it the blood from the branchia, and two series of circular orifices, of which the upper part are the *efferent* orifices of the pulmonary arch, and the lower are the *afferent* orifices of the floor of the lung. On this floor, in fact, the vessels which originate from these orifices, ramify in a network of which the efferent branches converge into a large trunk, overlooked by M. Jourdan, and which, collecting the blood of the whole of the floor of the lung, empties itself directly into the auricle.

From this results the fact, entirely exceptional in the Pectinibranchiata, that the auricle receives two totally distinct afferent veins. The one is branchial and pulmonary, the other exclusively pulmonary. This is a remarkable peculiarity of the anatomy of the *Ampullariæ*, which is in connection with the double respiration of these animals, and with the alternations in function of the double respiratory apparatus.

The afferent vessel of the branchia and the proper afferent vessel of the lung meet in front in such a manner as to form an anterior arch. The intermediate trunk meets this arcade very obliquely and under a very sharp angle open to the left. There is thus formed between the two vessels a valvular spur, which plays an important part in several respects. When, during sojourn in the water, the pulmonary respiration and circulation are suspended by the want of air and the collapse of the lung, the blood of the proper afferent vessel of the lung, being unable to traverse the pulmonary network,

arrives in abundance at the level of the mouth of the intermediary trunk, to which it applies the valvule and which it thus stops. It is thus obliged to pass entirely into the afferent vessel of the branchia, and, consequently, into the branchia, of which the activity is thus greatly increased. When, on the contrary, during sojourn in the air, the collapsed branchia does not act, the blood of the afferent vessel of the branchia, arriving *en masse* on the edge of the spur, there divides into two currents, one of which penetrates into the proper afferent vessel of the lung, and the other into the intermediary trunk, of which it augments the tension, and which distributes a part of it to the floor of the lung, and reconducts the rest to the heart. By this means the activity of the pulmonary circulation is increased during the repose of the branchia. Hence results this interesting fact, that the *Ampullariæ*, which are Pectinibranchiata in which pulmonary respiration has made its appearance, have the respiratory vessels disposed in such a manner that, when this newly-introduced function suspends its activity, all the blood which should have traversed the pulmonary network, is constrained to traverse the branchial system, where its hæmatosis is assured. This curious arrangement may suffice to explain the preservation of the branchia in Gasteropoda, in which the lung has attained so remarkable a development, and which might have become purely pulmonary animals.

The distribution of the vessels in the pulmonary walls merits special mention. They form a double system of portal veins; that is to say, the vessels form on their journey two successive networks separated by intermediary trunks. This arrangement, a little less accentuated on the floor than on the roof, added to the presence of a fine vibratile epithelium on the course of the pulmonary vessels, proves the active part of this apparatus as an organ of hæmatosis.

Doridæ of the Northern Seas.*—Dr. R. Bergh has a technical paper on this group; in his introduction he points out how few are the species—not more than twenty-two—that are known; he further states that Alder and Hancock, although they have brought into relief a number of anatomical differences, still recognize only three genera, *Doris*, *Lamellidoris*, and *Acanthodoris*. The author considers that there are a larger number of genera, and that these may be divided into two groups—to which he applies the names of Cryptobranchiatæ and Eleutherobranchiatæ, according as the gills are or are not retractile; the former group appears to be somewhat cosmopolitan and contains the genera *Archidoris*, *Diaulula*, *Cadlina*, *Joorunna*, *Aldisa*, and *Rostanga*; the latter is confined, so far as we know, to the colder regions, and contains *Acanthodoris*, *Adalaria*, *Lamellidoris*, *Goniodoris*, and *Doridunculus*.

Glands in the Foot of the Lamellibranchiata.†—M. Justus Carrière gives a short sketch of the very different views which have been held as to the characters of the byssus-gland, noting that Réaumur regarded the byssus as being formed by the glutinous

* 'Arch. für Naturg.,' xlv. (1879) p. 340.
† 'Arbeit. Zool.-Zoot. Inst. Würzburg,' v. (1879) p. 56.

matter secreted by the muscles, while Poli looked upon the muscular "languet" as being quite secondary. Blainville and others have regarded the byssus threads as being dried muscular fibres, and Leydig as being formed of chitinized fibres. The first correct account is due to A. Müller, who described the acinous *glandula byssipara* in the groove of the foot of *Mytilus;* Siebold (1848) agreed in the main with A. Müller, and suggested that the byssus threads were formed at the base of the byssal pit by lamellæ in very much the same fashion as the human nail is developed on the fingers. In 1877, Tycho Tullberg returned to the subject, and investigated the characters of the byssus in *Mytilis edulis;* he observed the presence of two glandular masses, one whitish and one greenish in colour; he found that the latter was placed towards the tip of the foot and opened by ramified tubes into the semilunar cleft, while the whitish gland was placed on either side of the groove and poured its secretion directly into it.

M. Carrière finds that in the anterior portion of the tongue-shaped and comparatively freely movable foot there is a large *byssus-gland,* which opens into a gland more or less semilunar in shape; this groove is directly connected with the cleft which extends along the margin of the foot, but it may, by the closure of its walls, form a somewhat semilunar canal. Behind the gland there is placed the "second characteristic organ," the byssus-cavity, which is occupied by fan-shaped processes, between which are placed the byssal lamellæ, which form the byssus proper.

As to the epithelium which covers these processes, it is to be noted that there is no *ciliated epithelium,* but only cylindrical cells, in those in which—e. g. *Mytilus, Dreissena*—the byssus is best developed; in those in which—e. g. *Pecten, Lithodomus*—the byssus has a less complete function of attachment, the processes are somewhat atrophied, and the non-functional regions *are* covered with ciliated epithelium; while in others—e. g. *Lima*—in which the byssus merely forms, with other substances, a kind of bed, the whole of the byssus-cavity is invested with ciliated epithelium.

It is, of course, impossible to follow the author through his extended observations on some twenty-five species; those of our readers who want his results in short will find on pp. 80–82 a list of the Siphoniate and Asiphoniate Lamellibranchs as to which M. Carrière is able to give any information. The author is of opinion that the byssus-lamellæ are secreted by the byssus "fans" or rather by the epithelium of these processes; while as to a more general result we may add this: the byssus-gland was primitively possessed by all the Lamellibranchiata, some of which have, in the course of time, lost it as a functional organ, but its presence is constantly indicated by the possession of rudimentary byssus-organs in the shape of glands, sacs, or clefts. The author also thinks that the orifices and clefts found in the foot only serve for the exit of the glandular secretions, and that they have no communications with the vessels or with the lacunæ of the body (in consequence of their unbroken investment of epithelium); if this view be cor-

rect it is clear that water cannot enter by them into the organ of Bojanus.*

Land Shells of Californian and Mexican Islands.†—Mr. W. G. Binney gives an important contribution to the geographical distribution of land shells.

The Mexican island of Guadelupe, 220 miles from San Diego, off the west coast of Lower California, has been visited by Dr. E. Palmer, and he found numerous fragments of snail-shells which had been devoured by a species of mouse, the only land mammal on the island. These appeared to belong to *Arionta Rowelli* (Newcomb), found in Lower California. *A. facta* occurred, a variety with open umbilicus, like that found fossil on San Nicolas Island, California. Living specimens of *Binneya notabilis* were brought from Guadelupe, found also on the Californian island of Santa Barbara; it is very nearly allied to if not synonymous with the Mexican genus *Xanthonyx*. Thus it is supposed to have been first distributed from Mexico, then to Guadelupe, thence to Santa Barbara.

Pompeian Conchology. ‡—Dr. N. Tiberi gives a list of forty-four species of shells found at Pompeii, and which had served for food or been used by the Pompeians for ornament and other purposes, with particulars of their relative abundance as well as of their distribution and economy.

Some were of eatable kinds as the oyster and mussel, *Pecten jacobæus*, *Venus chione*, *Tapes decussatus*, and several species of *Helix*. Others adorned fountains, as *Haliotis tuberculata*, *Murex trunculus*, and *M. brandaris*, and were all of species still common in the Bay of Naples. The Oriental pearl-shell (*Meleagrina margaritifera*) was represented by only a single valve. The Pompeian ladies seem to have attached considerable value to the *Cypræa* or Cowry as amulets against sterility, and among these shells were some of species from the Red Sea and Persian Gulf. A single specimen of the exotic shell *Conus textilis* must have been kept for its beauty as an object of curiosity.

Method of Obtaining Minute Mollusca.§—The Marquis de Folin describes the following method:—Specimens of the ooze from various shores, bays, and dredgings having been obtained, they should be washed with fresh water in a fine sieve, and then left to dry; if diatoms are being sought for, the results of the filtrations should be preserved, the water decanted, and the deposit left to dry. When dried, the objects should be placed in a box thus formed: the base should be formed of a piece of glass a decimetre square, provided with walls about one centimetre in height which should be fixed to the glass; it will then be possible, as the Marquis points out, to shake the deposit about with safety, while searching for objects of

* This Journal, *ante*, p. 551.
† 'Proc. Acad. Nat. Sci. Phila.,' 1879, p. 16; see 'Nature,' xx. (1879) p. 535.
‡ 'Tiberi, N., 'Le Conchiglie Pompeiane,' Napoli, 1879; see 'Nature,' xx. p. 624.
§ 'Bull. Soc. Imp. Nat. Moscou,' lv. (1879) p. 202.

interest. Similar means may be applied to the deposits left by streams of fresh water after any considerable increase in their height.

It is also possible to obtain a large number of minute species by carefully removing the mossy earth which is so frequently found near running water; when the water has been washed away and the mass carefully dried, a number of specimens will almost certainly be found. The author reminds his readers that specimens of distant fresh-water Mollusca can by this means be as easily obtained as can those marine specimens which are to be found in the bottom of bays or sea-washed shores.

Molluscoida.

Recent Species of Heteropora.*—Mr. Geo. Busk, referring to Mr. Waters's paper † on *Heteropora pelliculata* (from Japan), and *H. cervicornis* (from Adelaide), says that the occurrence of these two forms, belonging to a genus of which we had previously no species more recent than the Crag, and extending back to the Cretaceous period, is of particular interest, and he is induced therefore to indicate the existence of what may probably be a third species of the genus—one from New Zealand, which in most respects appears to bear a very strong resemblance to the Japanese form, if not specifically the same; there are one or two points in which they do not quite agree.

In the absence of more complete acquaintance with Mr. Waters's form, Mr. Busk provisionally designates the species,

Heteropora neozelanica, n. sp.? Zoarium erect, composed of short divergent branches, springing from a short thick stem, and soon dividing once or twice dichotomously, and terminating in blunt rounded extremities. The diameter of the primary branches is about ·2 inch, and of the terminal ones about ·1 to ·15 inch. The surface presents orifices of two kinds, though scarcely distinguishable in size. The larger ones in the older parts of the growth, have a slightly raised peristome and are quite circular; the others (cancelli) disposed more or less regularly round these, generally to the number of seven or eight, are more or less angular, and the border of the opening is never raised.

In the perfect state the surface, as in most Polyzoa, is covered with a thin chitinous pellicle, by which the cellular openings are more or less closed. This epithecal coat does not seem to become calcified or thickened, as in *H. pelliculata*, but always retains a delicate membranaceous character, and it is easily removed by caustic soda. Nor has he been able consequently to perceive the minute openings in the covering of the cancellar orifices described by Mr. Waters.

In sections the walls of the zoœcia and of the intermediate barren tubes or cancelli are perforated, as figured by Mr. Waters, by numerous infundibular pores, by which, as it would seem, facilities exist for the permeation of fluids throughout the entire zoarium. These pores and

* 'Journ. Linn. Soc. (Zool.),' xiv. (1879) p. 724.
† This Journal, *ante*, p. 390.

pore-canals are lined, like the zoœcia and cancelli, with a thin animal substance, which is readily dyed by any aniline colour, &c., by which means the pore-canals are rendered beautifully distinct in thin sections.

The chief points of difference between the New Zealand and Japanese forms would seem to consist (1) in the difference of habit —the branches in *H. pelliculata* appearing to be longer and more terete and to be occasionally connate, whilst in *H. neozelanica* they are short and not terete, expanding and never joined together; and (2) in the absence in *H. neozelanica* of the calcareous pellicle or epitheca, left after incineration in *H. pelliculata*.

Cyphonautes.*—Herr Repiachoff has some notes on this very interesting Polyzoan larva. He states that, by the aid of reagents, he has been able to show that the œsophagus (Schneider) passes gradually into a "vestibule" which is pretty sharply marked off from the next succeeding portion of the enteric tract. The "foot" (Claparède) or "bud" (Hatschek) is shown to be made up of two portions; a sucker-like thickening of the external epithelium, which is fringed by cilia, and a superiorly lying aggregation of cells, which occupies a similar position to the so-called "endodermal bud" of the larvæ of the allied forms *Pedicellina* and *Tendra*. The creature is, further, stated to be provided with distinctly striated muscular fibres. The retractile foot is regarded as being homologous with the "oral groove" of other Cheilostomatous larvæ, while their so-called "sucker" seems to be completely atrophied.

Arthropoda.

α. Insecta.

Nervous System of Insects.†—The results of M. Brandt's researches on 1032 species taken from most of the families of the *Hymenoptera*, *Coleoptera*, *Hemiptera*, *Lepidoptera*, *Diptera*, show that:—

i. In some forms, as *Stylops*, the subœsophageal ganglion fuses with the next posterior one. ii. The "convolutions" of the brain occur in all. iii. The convolutions vary in different individuals of the same species, and notably are less developed in males of the social Hymenoptera than in the females and workers. iv. A connection is apparent between the development of the instincts and that of the brain hemispheres,—not of the whole brain. v. The upper lip nerves rise from the œsophageal nerve-ring. vi. Where two thoracic ganglia exist, the first corresponds either to the first larval ganglion or to the first two; the second of the adult corresponds to one or two thoracic and one or two abdominal ganglia. vii. The number of ganglia may vary in different individuals of the same species—e. g. in the bee and in the wasp. viii. The penultimate abdominal ganglion may be complex, instead of the ultimate one. ix. *Bombus* and *Tenthredo* have a thoracic sympathetic system constructed like that of the abdomen. x. Two types of transformation occur in the nervous system; one, the inverse of that usual in insects, being the resolution

* 'Zool. Anzeiger,' ii. (1879) p. 517.
† 'Comptes Rendus,' lxxxix. (1879) p. 475.

of a single larval ganglion into a number in the adult, as in *Volucella*. xi. In cases of a single thoracic ganglion in Hemiptera, this corresponds to the two last thoracic and all the abdominal ganglia. xii. Lepidoptera have four abdominal, and either two or three thoracic ganglia.

Cephalic Ganglia of the Insecta.*—M. N. Wagner points out the supra-œsophageal ganglia are the seat of almost all the functions which are performed by the cerebral hemispheres of the Vertebrata—they contain the organs of perception, of memory, and of intelligence. In correlation with this they present a more complicated histological structure than the rest of the ganglia of the insect's body, although they are formed on the same general plan. The nerve-cells occupy the periphery, and the bundles of nerve-fibres the central portion; towards the centre of the ganglion there are to be found three groups of small cells, set one above the other, and connected by a large number of fibres. The most peripheral group may be considered as having the most intimate connection with the horse-shoe-shaped convolutions, which are particularly well developed in the social Hymenoptera, which are the most intelligent of all the insects; and it is to be noted that the degree of development of this region is to be correlated with the development of the intellectual powers; for example, if we take the bee, we find these parts to be better developed in the workers than in the queen-mother, while in the males they are quite rudimentary. M. Wagner concludes that the sexual life, and above all the production of ova and sperm, is opposed to the development of these organs.

The crossing of the nerve-fibres which pass to the eyes is not to be compared with the "optic chiasma" of the Vertebrata, as it only applies to the constituent parts of the lateral compound eyes; at the same time this crossing of the fibres probably produces a complete coincidence in each part of the composite eye.

The preparations studied were previously hardened in Betz's liquid, made of equal parts of sulphuric ether and chloroform.

Brain of the Cockroach.†—Mr. E. T. Newton gives an account of his researches on the minute structure of the brain of *Periplaneta orientalis*.

After an abstract of previous work on the subject, Mr. Newton describes the external anatomy of the brain as made out by sections, and the nerves proceeding from it. Of these he gives a very exact and detailed description, many of the nerves having been observed by him for the first time.

The section of the paper treating of the internal structure of the brain cannot readily be abstracted, and we must refer the reader to the original source, where the description is by no means long. Mr. Newton deserves the thanks of comparative anatomists for proposing a consistent nomenclature for the various structures, hitherto only known by Flögel's vernacular terms. That author's "Balken" is

* 'Comptes Rendus,' lxxxix. (1879) p. 378.
† 'Quart. Journ. Micr. Sci.,' xix. (1879) p. 340.

called the *trabecula*, the "Vorderhorn" becomes the *cauliculus*, the "Hinterast" (Pilztheil, Dielt), the *peduncle*, the "mushroom body" of authors the *corpus fungiforme*, its trough-like portions—"Becher" of Flögel—the *inner* and *outer calices*, and the "Centralkörper" the *corpus centrale*.

The most successful sections were prepared from a specimen hardened in osmic acid.

Nerves of the Proboscis of Diptera.*—M. Jules Künckel has examined into the terminations of the nerves in the proboscis of the Diptera. He remarks that the proboscis terminates in two valves, which, in repose, are laid against each other, but during suction are applied to the surface attacked so as to constitute a regular sucking cup. These valves represent the labial palpi. Their internal structure presents a peculiarity well known to microscopists; they contain a large tube, from which issue numerous branches in a digitate form, and all these parts present an appearance like that of tracheæ. The name of *false tracheæ* which has been given to them is perfectly justified, as they have no communication with the true tracheal apparatus, their principal function being to support the integuments of the palpi, whilst a true trachea ramifies in these organs. Parallel to the large trunk of the false tracheæ the labial nerve may be traced, of comparatively large size. It speedily divides into two parts, and emits a multitude of ramifications to the periphery and inner surface of the valves. Those nervous filaments which run to the periphery go to the numerous and greatly developed hairs with which the margin of the valve is furnished; those which go to the inner surface, on the contrary, terminate at rudimentary hairs, reduced to a minute chitinous cylinder.

On examining the nervous terminations which run to the marginal hairs, it will be found that a filament separates from the ganglionic inflation, and goes to the hair, as has been already described and figured by M. Jobert, but that it terminates in the interior of the hair at the point where the latter is joined to the integument by a membranous part. On the other hand, in the case of the terminations which go to the rudimentary hairs, the filament will be seen to traverse the little cylinder and project outside in the form of any fine and delicate rounded point. There are thus in the proboscides of the Diptera (Muscidæ and Syrphidæ) two kinds of nervous terminations —one set connected with well-developed hairs, which are no doubt tactile in function; the other, with rudimentary hairs of peculiar form, which are probably gustative.

Sense-organs of Insects.†—With regard to the results announced by Professor Graber,‡ as to the presence of an otocyst in the antennæ of certain Diptera, Dr. Mayer declares that independent investigations made by himself on the same species show that the organ in question is open to the exterior, and therefore not otocystic. Further, he

* 'CR. Assoc. Franç. Avancem. Sci.,' 1878 (1879) p. 771; see 'Pop. Sci. Rev., iii. (1879) p. 444.

† 'Zool. Anzeiger,' ii. (1879) p. 182.

‡ 'Arch. Mikr. Anat.,' xvi. (1878) p. 36; see this Journal, *ante*, p. 45.

states that in *Sicus* and *Eristalis* additional organs of this kind—and in *Musca vomitoria* as many as fifty of them—occur in the same terminal segment of the antenna. From their structure and innervation he would still regard them as sensory, but leaves the question of their exact function to be settled by physiological experiment.

Dr. H. Krauss identifies the fly-larva in which Professor Graber claimed * to find an otocyst, as that of *Tabanus autumnalis* Linn., a species remarkable in its genus for its aquatic habits in its earlier stages. The organ referred to is found also in the perfect insect.

Scales of the Lepidoptera.—In his 'Physical Description of the Argentine Republic,' † Dr. H. Burmeister devotes a chapter to a special examination of the scales of the Lepidoptera.

After remarking that the whole life of a special observer would not be sufficient to recognize the innumerable variations in the scales of even a single species, and describing the general structure of the scales, Dr. Burmeister comes to the question of the markings on their surface, and states that notwithstanding the trouble that the question has already given to naturalists, he considers himself able to say, as the result of his own researches, that any difficulty is now cleared up.

The scales which he studied were those of different species of the genus *Castnia*, which has the largest of any insect.

According to his observations the scales do not enclose any third membrane, but are empty, the two membranes of which they are composed not touching each other, but leaving a certain space between them, a construction which is plain in the white and transparent scales. Those which are coloured, contain a fluid colouring matter at the commencement of the formation of the scale, which dries little by little by the influence of the air, and leaves a deposit on the inner surface of the two membranes, the fluid being finally replaced by the air entering through the membranes, which remain soft for a short time after the formation of the scale. The colouring matter seems to be principally attached to the upper membrane, rendering it opaque, whilst the lower one receives less of the deposit, and remains, consequently, somewhat more transparent, and even without any deposit in many insects.

Dr. Burmeister's researches have proved to him that the fine longitudinal striæ belong entirely to the *upper* membrane of the scales, and are wanting in the lower.

The longitudinal striæ are very regularly distributed with equal intervals, though somewhat different in different scales. The breadth of the spaces between the lines is always greater than that of the lines themselves, while the lines are in general of equal breadth, though there are some scales where coarse lines alternate with finer ones. This distinction of coarse and fine lines the author has seen plainly in scales with an indented terminal margin, and found that the coarse lines correspond to the teeth of the margin, whilst the others correspond to the intervals between them.

* Loc. cit.

† 'Description Physique de la République Argentine,' vol. v. "Lépidoptères," part i. p. 21, 8vo, Buenos-Ayres, Paris, and Halle, 1878.

There is no doubt that these markings are due to filaments which are elevated on the inner side of the upper membrane, and appear from the exterior as fine striæ. In the large scales of *Castnia* it can be seen very clearly that they do not entirely traverse the interior of the scale, but terminate free, leaving an interval between them and the lower membrane.

The latter presents internally a completely different structure. There are a great number of small, irregular, transverse lines (somewhat similar to those on the palm of the hand), showing none of the regular arrangement of those on the upper membrane.

According to M. Deschamps and other observers, the intervals between the longitudinal lines are divided regularly by transverse ones, thus forming small squares, giving the scales a trellised appearance, and originating many errors in regard to their true structure. Exact observations, however, on scales in which the two membranes were dissected apart, have shown that this is a deception, and that the appearance is produced by the lower set of striæ showing through the upper transparent membrane.

Dr. Burmeister's views are, we need hardly say, opposed to those of Mr. Beck,* and would appear to be disproved by his well-known experiment of running moisture up and down in the furrows between the "corrugations" on the under surface of the scales.

Butterflies with Dissimilar Sexes.†—Mr. Meldola has an interesting review of Fritz Müller's paper in 'Kosmos,' on this subject, the phenomena of which have been well described by Mr. S. H. Scudder, under the name of "Antigeny." The principal object of the author is to show that in some cases the male, and not the female, is the selecting partner. Dealing with *Epicalia acontius*, of which the sexes are so separate that they have been placed by some systematic zoologists in even different genera, while Fabricius applied the specific name of *Antiochus* to the male and of *Medea* to the female; the author shows what is the extent of the difference by describing what obtains in the two sexes; in both sexes the general ground colour of the wings is black, the male has a broad oblique bar of a bright orange colour extending from about the middle of the inner margin of, to about the middle of the fore-wing in the direction of the apex; as there is a corresponding blotch near the middle of the hind-wing, the whole forms, when the wings are extended, one oblique orange bar; now, the female has two oblique rows of pale yellow spots across the fore-wings, which run nearly parallel with the costal margin, and there are two similar rows across the hind-wings, and these, with extended wings, give rise to the appearance of three straight parallel rows (which are continued on to the body by spots of the same colour).

It is to be noted that the hindmost row of spots "have been distorted so as to form a straight bar parallel with the other rows; this results from the displacement of the spots, each of which, although situated in one wing-cell, does not appear on the *corresponding place* in each cell; were this the case, the row would be curved instead of straight. That it was the sense of beauty of a critical eye, which

* See *ante*, p. 810. † 'Nature,' xix. (1879) p. 586.

straightened the original curved row of spots to a straight bar, is strikingly shown by the two foremost spots of the row, which are unsymmetrical with regard to the corresponding row on the front wings, and which really form the commencement of a curved bar—*but these are hidden by the overlapping* of the front wings." It is supposed that the critical eye was the eye of the male.

Adoption of an Ant-queen.*—The Rev. H. C. McCook reports the following case of the adoption of a fertile queen of *Crematogaster lineolata*, a small black ant, by a colony of the same species. The queen was taken on April 16th, and on May 14th was introduced to workers of a nest taken the same day. The queen was alone within an artificial glass formicary, and several workers were introduced. One of these soon found the queen, exhibited much excitement, but no hostility, and immediately ran to her sister workers, all of whom were presently clustered upon the queen. As other workers were gradually introduced they joined their comrades until the body of the queen (who is much larger than the workers) was nearly covered with them. They appeared to be holding on by their mandibles to the delicate hairs upon the female's body, and continually moved their antennæ caressingly. This sort of attention continued until the queen, escorted by workers, disappeared in one of the galleries. She was entirely adopted, and thereafter was often seen moving freely, or attended by guards, about the nest, at times engaged in attending the larvæ and nymphs which had been introduced with the workers of the strange colony. The workers were fresh from their own natural home, and the queen had been in an artificial home for a month. As among ants the workers of different nests are usually hostile to each other, this adoption of an alien queen is an example of the strong instinct which controls for preservation of the species.

Mode of depositing Ant-eggs.†—Mr. McCook also states that a queen of the black carpenter ant, *Camponotus Pennsylvanicus*, which had long been kept in an artificial nest, had once been seen in the act of depositing an egg. The queen was at the time clinging to the side of a hollow in the surface of the earth, almost in a vertical position. The usual body-guard of workers quite surrounded her, continually touching her with their antennæ. The egg was a white cylindrical object, about one-eighth of an inch in length. It was about two minutes in escaping from the body, and as soon as dropped was carried below within the galleries by a worker. The queen was never left by her body-guard, who sought to control her movements by pressing around her, blocking up the path which she wished to take. Frequently more vigorous persuasions were used, an antenna or leg being grasped by a worker, and the queen thus pulled backward. She made no attacks upon her guard, but often stubbornly held her own way; though commonly yielding more or less graciously to her attendants. This colony had been received from the Allegheny Mountains in December, within their formicary in an oak bough, in which they were hibernating, being quite stiff with cold. They immediately revived in the warmth, and were healthy and active during the following

* 'Proc. Acad. Nat. Sci. Philad.,' 1879, p. 137. † Ibid., p. 140.

spring. The queen survived until September following, and would doubtless have lived longer had she not been neglected during a prolonged absence in summer. She outlived all her subjects, and was certainly more than a year old.

β. Myriapoda.

New Pauropod.*—Mr. J. A. Ryder describes a new Myriapod, which is nearly allied to the form first described by Sir John Lubbock under the name of *Pauropus*, in reference to the fewness of its feet. The specimens obtained are ten in number, and have but six segments, fewer than any other known member of the group, whilst the number of pairs of legs is nine, the same as in *Pauropus*, which is very strong evidence that the specimens are adults. The following characterization of the genus and species is proposed:—

Eurypauropus spinosus, gen. et sp. nov. Body segments six in number, sixth exceedingly rudimentary; antennæ five-jointed; legs in nine pairs, equidistant; tergal sclerites laterally expanded so as to conceal the legs almost entirely when the animal is viewed from above, and covered with fine tubercles which are joined to each other by raised lines; appressed curved spines are also scattered over their surface in less number, and also fringe their margins, being disposed at regular intervals; the spines and lines give the dorsal surface of the little creature a slightly silky lustre when viewed with reflected light. Colour a delicate light brown. Mouth-organs the same as in the first-described genus. No evidence of eyes could be detected. Length $\frac{1}{25}$ of an inch; width about $\frac{1}{70}$ of an inch. Habitat in Fairmount Park, Philadelphia, east and west of Schuylkill, in moist situations under sticks and decaying vegetable matter.

The tergal sclerites are much thicker than in *Pauropus*, having the characteristic brown colour of chitin when viewed with transmitted light. The antennæ have the terminal globular hyaline body with a long pedicle as in *Pauropus pedunculatus*. The type is the most distinct form discovered since the detection of the first known representatives in England in 1866, and also extends the geographical range of the family, and does much towards fully establishing the Pauropoda as a distinct order of Myriapods.

γ. Arachnida.

New Division of the Tarantulida.†—Dr. Karsch proposes the following division of the *Tarantulida*:—

1. All the six true legs are formed in the same way (i. e. the fourth pair has no tibial joint).

 Phrynichus:—type sp. *P. reniformis* Linn.

2. The legs of the fourth pair have each a single tibial joint.

 Damon (C. L. Koch):—type sp. *D. medius* Herbst.

3. The legs of the fourth pair have two tibial joints, and the anterior one is the shorter.

 Tarantula Fabr.:—type sp. *T. pumilio* (C. L. Koch).

4. There are three tibial joints.

 Charon:—type sp. *Charon Grayi* Gervais.

* 'Proc. Acad. Nat. Sci. Philad.,' 1879, p. 139, and 'Am. Nat.,' xiii. (1879) p. 60.

† 'Arch. Naturg.,' xlv. (1879) p. 189.

Differences between the Young and the Adult Forms of the Gamasidæ.*—Dr. Kramer's paper on this subject deals especially with the criticisms of M. Mégnin, who stated (1) that the absence of the holding lobes from the anterior pair of feet was peculiar to females and nymph-forms, (2) that the dorsal shield was only cleft in nymphs, and (3) that the margin differs in form in nymphs and in the different sexes. Kramer, however, is by no means satisfied as to the accuracy of these views, and he states that he has only observed in a single species the absence of the holding lobes, that he has had under observation adult females of species of *Gamasus* in which the dorsal shield has been divided, while as to the characters of the margin, howsoever they vary, the variation is not such as to render their specific characters obscure.

Pairing of Spiders.†—The Rev. H. C. McCook describes minutely the pairing of a male and female of *Linyphia marginata* which he witnessed in June, 1878. The observation is too long for our space, but it may be mentioned that the pair were in union for 2 hours and 55½ minutes, during which period they were separated nineteen times in consequence of various interruptions, some of which could be accounted for, but others were apparently without any extraneous cause. Twice the male ran to one side of the dome, made a web attachment to a bit of leaf hanging in the snare, drew out a thread about 2½ inches long, which he overlaid a couple of times, and then made the following motion: First, the body was placed erect, i. e. back upward, and was moved backwards and forwards along the line, rubbing the points or "nippers" of the palps at the same time; then the spider swung over until the body made an angle of about 45° with the line, and while holding on thus the palps were rubbed back and forth alternately along the line as before. The process was repeated during another of the intermissions. It was conjectured that the purpose of this movement might be the distribution of the seminal fluid into the palpal bulbs. This is taken up by the sacs, by the inflation and contraction of whose membranous coats it is forced into the spermathecæ of the female.

Observations on the Pycnogonida.‡—Nearly ten years ago Dr. Dohrn published in the 'Jenaische Zeitschrift' an essay on the structure and development of the Pycnogonida, which he was led to place with the Arachnida, rather than with the Crustacea, on account of the presence of seven pairs of appendages; the three pairs found in the larva were seen to be converted into the maxillary palpi, antennæ, and accessory or ovigerous feet; as to the last it was shown that they were formed at the same time as the first pair of true legs, and that therefore there could be no relation between them, in the way of one being developed from the other.

Professor Semper has lately been investigating the history of the same group, and has come to certain conclusions § with which we will

* 'Arch. Naturg.,' xlv. (1879) p. 238.
† 'Proc. Acad. Nat. Sci. Philad.,' 1879, p. 150.
‡ 'Mitth. Zool. Stat. Neapel,' i. (1878) p. 28.
§ 'Arbeit. Zool.-zoot. Inst. Würzburg, i. p. 264.

deal, after having, with Dohrn, directed attention to the fact that the investigations of the Würzburg professor seem to set at rest a question which has been differently answered by different observers. The genus *Phoxichilidium*, which has been lately subjected to examination, is, in its larval stages, parasitic on *Hydractinia;* according to Gegenbaur, the parent lays its eggs in the polyp, whereas Hodge and others state that the larvæ enter the polyp so soon as they leave the egg; among the latter is Claus, and that he was right in his view is shown by Semper's detailed account.

Turning to the points on which Semper and Dohrn are at variance, between *Phoxichilidium*, as described by the former, and *Achelia*, as described by Dohrn, there is this difference, that in the former the ovigerous appendages are a later development and are not represented in the larva, so that the Pycnogonida apparently have not as Dohrn imagines seven, but only six pairs of true appendages. So far as this bears on the relationship of the Pycnogonida with the Arachnida, which as Professor Semper thinks is rendered doubtful by their possession of only six pairs of legs, Dohrn remarks that "the homologies of the appendages will only be proved when the blood-relationship of the separate orders of the Arthropoda has been demonstrated by some other method." In addition to this "theoretical" consideration Dohrn asserts that Semper is wrong in his facts. The great and important point is the character of the nervous system: with regard to the first ventral ganglion, it gives off three pairs of nerves; the first, which is not noticed by Semper, supplies the rostrum and its musculature, its sensory hairs and complicated lips; the second pair supplies the so-called tentacles, or those appendages which are intercalated between the rostrum and the ovigerous appendages: the third pair pass to the ovigerous appendages and present the same morphological relations as the second pair.

In the larva, the first pair of legs are supplied by a nerve given off from the supra-œsophageal ganglion and the two hinder pairs by two distinct nerves, which arise from two incompletely separated *ventral* ganglia; from this it is clear that these two larval extremities are not equivalent to the appendages of one segment, but are two "homodynamous structures." The larva is therefore provided with three pairs of appendages, and as four other pairs are developed later on, Dohrn's original view that there are seven pairs of appendages in the Pycnogonida is true for all cases in which the larval legs persist; and even when the third pair disappear, as Semper has shown them to do in the case of *Phoxichilidium*, the nerve still retains its old morphological relations, and supplies the horseshoe-shaped ridge which is the final remnant of the ovigerous appendages. From the point of view then of development and of nervous relations the "typical" character of the ovigerous legs (the third pair in the larva) as true appendages appears to be well established.

Professor Semper has, however, yet another argument; he asserts that in all Pycnogonida cæcal gastric sacs are "typically" continued into the appendages: of the third of these sacs he states that it

goes to that segment of the body which in the larva bears the third pair of larval legs and in the adult the first pair of true legs. But Dohrn asks how these sacs are made out to be typical rather than the generative cæcal sacs of which only four pairs are developed; in fact they cannot be in any sense regarded as typical, inasmuch as in some genera there are *no* cæcal sacs for the palp or the ovigerous appendages; while in others there are two pairs, and yet again in others only one. Semper asserts that there are only six paired ganglionic masses in the body, while Dohrn states there are eight.

The statement of Cavanna that the egg-pouches are found only on the male is supported; and the blood-corpuscles are stated to be enormously large. Dr. Dohrn announces that he is preparing an account of the *Pycnogonida* of the Gulf of Naples.

δ. Crustacea.

Structure of the Nervous System of the Decapodous Crustacea.* —In the summary of his results M. Yung enters into somewhat greater detail than he did in the 'Comptes Rendus,'† and we are able to add one or two points of importance.

The author points out that the absence of a differentiation of myelin and of the axis-cylinder which is to be observed in the central nervous system of Vertebrates, together with the form and composition of the cells, brings the central nervous system of the Crustacea into very close affinity with the sympathetic system of the Vertebrata, the only difference between them being one of size.

The thoracic ganglia of the Macrura have a similar structure to the abdominal ganglia, and the slight differences between them may be seen to be due to the concrescence of several ganglionic masses; this is best and most strikingly seen in the Brachyura, where there is only a single thoracic ganglion. As already stated, the brain seems to be formed of three ganglia, and it is possible, we may add, to distinguish anterior, lateral, and posterior protuberances; these are formed by a compact medullary mass, which is finely dotted, and is divided into a number of more or less cubical portions by fine lamella of connective tissue, and distinguished histologically by being more deeply coloured by osmic acid than is the rest of the nervous substance; the medullary mass is covered by a layer of nuclei, but it is not possible to distinguish any cellular investment; the nerves of special sense have their origin in the superficial cells of the protuberances, but it is not easy to say exactly whence any particular nerve arises.

It is interesting to observe that the studies of M. Yung confirm the theoretical views, long ago propounded by M. Milne-Edwards, as to the presence of three pairs of ganglia in the brain.

Physiology of Muscle and Nerve in the Lobster.‡—MM. Fredericq and Vandevelde have contributed a paper on this subject to the Belgian Academy. Their conclusions are as follows:—

* 'Arch. Zool. Exp.' (Lacaze-Duthiers), vii. (1878) p. 449.
† See this Journal, *ante*, p. 419.
‡ 'Bull. Acad. Roy. Sci. Belgique,' xlvii. (1879) p. 477.

1. There appears to be complete identity of properties between the muscles of the lobster and those of the frog.

2. The motor nerves of the lobster present, from a physiological point of view, strong points of resemblance with those of the frog. The most characteristic difference consists in the slowness with which the motor excitation travels along the lobster's motor nerves (6 metres a second in the lobster, 27 metres in the frog). The propagation of the motor excitation undergoes, in the lobster, a considerable retardation in the muscular terminations of the motor nerve.

Action of Electric Currents on the Pincer of the Crayfish.*—By the aid of the graphic method, and the slowness with which the muscles of the pincer effect their contraction, M. Richet has been able to show that the form of the muscle-wave varies with the intensity of the electric currents which effect it; it is short when the currents are feeble, although longer than in the muscles of the frog. When the intensity of the current is increased the form alone changes; the fall of the curve is at first rapid and then gradually slackens. As the current is increased in intensity the second period increases in length, and the former diminishes until at last it may be seen to completely disappear; and it follows from this that it is not the height but the duration of the muscular contraction which increases with the increased intensity of the exciting currents. That the contraction is due to change in the muscle itself, so far, at any rate, as its second portion (that of gradual relaxation) is concerned, is shown by the fact that this "contracture," as the author calls it, is barely apparent when the motor nerve is itself directly excited. The myographic traces obtained were found to be remarkably similar to those exhibited by muscles poisoned by veratrin. These observations may be taken as supplementary to those previously recorded.†

Atlantic Stalk-eyed Crustaceans.‡—Mr. S. J. Smith, of Yale College, publishes an account of the stalk-eyed crustaceans of the Atlantic coast of North America. It forms part of the report in preparation for the United States Commission of Fisheries, and embodies the study of the extensive collections made during the past fourteen years by Professor Verrill and himself.

In the present paper only the species inhabiting the coast between Cape Cod and Northern Labrador are given, and although the paper has special reference to the geographical distribution of the species, considerable matter is introduced in regard to specific variation and specific characters, and under some of the species, to the synonymy, especially where it seemed necessary to the proper understanding of the geographical distribution, or to show the propriety of the nomenclature adopted, or where the species is not well known.

* 'Comptes Rendus,' lxxxviii. (1879) p. 1272.

† This Journal, *ante*, p. 562.

‡ 'Trans. Connecticut Acad. Arts and Sci.,' v. (1879); 'Nature,' xx. (1879) p. 535.

The total number of species recorded is 73, of which 45 are Decapods, 11 Schizopods, and 17 Cumaceæ, one-half of which are also to be found in Europe, the author concluding that there is not only a close relationship between the marine fauna of Greenland and that of Northern Europe, but a similar close one between that of Greenland and of the coasts of the continent of North America.

Some New Cymothoida.*—Herr Koelbel describes some new species of this group from various localities in a paper which is illustrated by two plates; among these is a representative of a new genus *Emphylia*, which is allied to *Nerocila* of Leach, but is distinguished from it by the approximation of the bases of its internal antennæ. The single species receives the name of *ctenophora*, and the habitat is stated to be Akyab. There are no points in the paper of general interest.

Trilobites and Limuli.†—Professor E. von Martens recapitulates the history of the Trilobites, which, so characteristic of Silurian deposits, are never found in any strata later than those of the Permian epoch. He points out that their relationship to the Isopoda is opposed by the freedom of the head in these latter, and by their constant possession of seven thoracic and seven abdominal segments, while in the Trilobites the cephalic and thoracic portions are always fused and the number of segments is inconstant. With regard to the view of Professor Claus that the Trilobites are allied to the Phyllopoda, it is allowed that in these extant Crustacea numerous points of similarity are to be observed.

Turning to the *Limuli* (American king-crabs) the author points out that they are to be distinguished from all other forms of Crustacea by the fact that there is only one pair of præ-oral appendages; in this point they agree with the Arachnida, and with this class some modern zoologists would place them; when, however, we consider the points by which the Crustacea and Arachnida are distinguished, and then study the characters of *Limulus*, we may see that the view of Professor von Martens is, at any rate, highly probable. The Arachnida are remarkable for the absence of abdominal appendages, the presence of simple eyes only, the straight intestine, and the possession of Malpighian vessels. None of these characters are presented by *Limulus*; it, like all Crustacea, has abdominal appendages, branchial organs, genital orifices situate at the boundary between the thorax and abdomen, compound eyes and a true proventriculus. Observation of living forms has recalled to Professor von Martens the great similarity between *Limulus* and the Phyllopod form *Apus cancriformis*, and he concludes with stating that in his opinion we have both in the case of *Limulus* and of the Trilobites, to do with special and isolated orders of the Crustacea, both of which have taken their origin from the Phyllopoda.

* 'SB. Akad. Wiss. Wien,' lxxviii. (1879) p. 401.
† 'Naturforscher,' xii. (1879) p. 377.

New Species of Chirocephalus.*—Mr. John A. Ryder, observing that this genus does not seem to have been noticed in North America, announces the discovery of a hitherto undescribed species in New Jersey, where it was found in abundance in the ditches.

The genus, as characterized by Dr. Baird,† has been found in Switzerland, France, England, Russia, and Siberia. The species *C. lacunæ*, most nearly like the one now discovered, is figured and described by Guérin in his 'Iconog. Règne Animal,' as being found at Fontainebleau. The differences between the species are, however, sufficiently striking and constant to characterize a well-marked specific type, for which the following characterization is proposed.

Chirocephalus Holmanii, nov. sp.

Char. specif.—Claspers moderately robust; second joint forked, longest branch longer than first joint, and curved inwards, its tip crossing that of its fellow of the opposite side when in repose; shorter branch, less curved, slightly swollen, and rough on the inner surface of its tip, about half as long as the longer branch. Two long, fleshy, proboscis-like prehensile organs arise from the bases of the claspers and are coiled up between the latter; muscular fibres pass throughout their length; near their origin and for the first third they are expanded inferiorly into a thin margin with about seven papilliform processes; they then gradually contract, becoming cylindrical at their second third, where about seven well-marked digitiform processes are found, the longest of which are about as long as twice the diameter of the proboscis at this point; the remaining third gradually contracts, and is thickly studded with half-rings of small papillæ which seem to mark indistinctly the segments of the organ. Total length of the proboscis, when extended, about three times that of the claspers. Total length 12–14 mm. Habitat, Woodbury, New Jersey.

The specific name is given in honour of Mr. D. S. Holman, in recognition of the services he has rendered in devising methods for studying living objects, both large and small, under the Microscope.

Reproductive Organs of Non-parasitic Copepoda.‡—A monograph on this subject is published by Dr. August Gruber, of Freiburg.

1. *Testis and Vas deferens.*—The primitively double testis is, in all free forms, a single, usually pear-shaped gland. The vas deferens is always divided into three parts, differing in structure and function. The first portion extends at first backwards from the testis, often has a strong curve forwards at the end of its course, and is provided with a very narrow lumen. The second portion is more or less convoluted, and differs from the first mainly in being considerably dis tended by the quantities of seminal fluid (Samenmasse) stored up in it;

* 'Proc. Acad. Nat. Sci. Philad.,' 1879, p. 148.
† "Monograph of the Family Branchipodidæ," 'Ann and Mag. Nat. Hist., xiv. (1854) p. 216.
‡ 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 407.

the spermatophore takes its origin in this segment. The third portion, the spermatophoral sac or *ductus ejaculatorius*, is usually short and thick-walled; in it the formation of the spermatophore is completed. The author points out that this division into three parts of the male genital duct corresponds with a similar state of things described by Grobben in the *Decapoda*.

The ripe spermatozoa accumulate at the anterior end of the testis, and are carried off along the first segment of the vas deferens, the lumen of which is so small, that often only two can lie side by side. Arrived at the second segment, they accumulate at its hinder end, being prevented from entering the third segment by a pylorus-like constriction between the second and third. The second portion of the duct becomes so swollen out by the accumulation of sperm, that its walls are reduced to a very thin membrane; this accumulation proceeds up to the bend which marks the line of juncture of the first and second portions.

Even in the first portion of the duct there is seen to be a granular secretion of its wall among the spermatozoa, as well as a delicate investment, also a secretion of the wall, around them. In the second segment these two secretions have become much more important, and there can be distinguished, from without inwards, (1) the thin investment; (2) the layers of spermatozoa; and (3) the central mass of granular cement-substance.

The rudiment of the spermatophore thus constituted is partly pushed through the valve into the third segment of the duct, and the greater part of it is constricted off to form the spermatophore, part, however, remaining in the second segment, ready to begin the formation of a new spermatophore.

The author does not believe in the existence of the special secretion (Sprengstoff or Austreibstoff) described by some observers, having for its function the emptying of the spermatophores.

The first section of the paper concludes with a description of the male organs in the *Cyclopidæ*, the *Harpactidæ*, the *Peltidiæ*, the *Corycæidæ*, the *Calamidæ*, and the *Pontellidæ*.

2. *The receptaculum seminis and the formation of the egg-sacs.*—This section treats of the female organs in the *Calamidæ*, the *Cyclopidæ*, and the *Harpactidæ*. The author sums up his results as follows:—"Amongst the *Copepoda* some species are found devoid of a special receptaculum, others with a pair of symmetrically disposed receptacula, and others again in which the organ is unpaired, and lies in the middle line of the abdomen. In the first case, the semen, surrounded by the cement-substance of the spermatophore, is simply inserted into the vulva, in both the other cases the seminal capsules empty themselves, usually through a special pore, into the receptacula, from which the semen makes its way, during the extrusion of the eggs, into the vulva. The receptacula are never also cement-glands, but the secretion which forms the egg-sacs is a product of the oviduct, the terminal portion of which it fills as a clear, delicate mass, which sets in water.

The Notodelphyidæ.*—M. L. Kerschner describes two new genera of the curious Copepod family Notodelphyidæ, each including a single species, which he names *Paryphes longipes* and *Dorsipys uncinata*.

He prefaces his descriptions with some corrections of previous notions as to certain points in the organization of these crustaceans. He shows that the brood-chamber, which is usually regarded as contained within the body-cavity, is formed, in the majority of Notodelphyidæ, by a duplicature of the integument of the body proceeding from the dorsal surface of the fourth and from the sides of the fourth and fifth segments, but that in two genera this duplicature is inserted even upon the second thoracic segment. He further indicates that an unpaired ovary is present, and that the ova pass in strings into the oviducts (formerly "ovaries").

The author confirms a part of Thorell's observations upon the connection of the female generative organs, and, by the discovery of the hitherto overlooked external genital aperture of the female, brings back these organs to the general type of the whole order.

In all the males observed he describes an unpaired testis, and represents the envelope of the spermatophores as secreted by the wall of the whole of the seminal duct. In the spermatophore itself he recognizes more layers than Thorell. He describes the type on which the nervous system is constructed, and in opposition to Buchholz, asserts the presence of olfactory nodes.

New British Entomostraca.—The very curious translucent Entomostracon *Leptodora hyalina*, which was first found in the deep Swiss lakes, and subsequently in other parts of Europe, has now been found in England, first in the Olton Reservoir, near Birmingham (in the masses of a minute alga, *Clathrocystis*), and subsequently in two other localities, and was described † by Mr. Graham, the President of the Birmingham Natural History and Microscopical Society, with a drawing by Mr. Forrest.‡

In the Olton Reservoir (and subsequently in a second locality) there was also found an Entomostracon, new to Britain, which was at first supposed to be a new species and so described and figured in the 'Midland Naturalist' § ("*Daphnia Bairdii*"), but was subsequently recognized by Professor Lankester as *Hyalodaphnia Kahlbergensis* of Schödler. Only the female was found.

Vermes.

Segmentation in Worms and Pulmonates.‖—Dr. W. Mayzel, of Warsaw, confirms Auerbach's observations as to the changes undergone by the nucleus in the dividing egg of *Ascaris nigrovenosa* and of *Strongylus auricularis*. In both these species, as well as in *Limax variegatus*, he found the now well-known caryolytic figures—the spindle

* 'Anzeig. Akad. Wiss. Wien,' June 13, 1879; 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 321.
† 'Midl. Nat.,' ii. (1879) p. 225.
‡ See also Mr. Forrest's paper, *ante*, p. 825.
§ 'Midl. Nat.,' ii. (1879) p. 217.
‖ 'Zool. Anzeiger,' ii. (1879) p. 280.

nucleus, nuclear disk, "suns," &c. His observations, therefore, tell strongly against Brandt's amœboid theory of nucleus-division, according to which there is no real differentiation of the nucleus, the fibres described in it being merely folds in its membrane, and the "suns" at its poles, radially arranged nuclear processes or pseudopodia.

Prizes for Life-histories of Entozoa. — The council of the Entomological Society of London are authorized by Lord Walsingham and other gentlemen interested in the diseases of our native game-birds to offer to public competition the following prizes:—

50*l.* for the best and most complete life-history of *Sclerostoma syngamus* Dies., supposed to produce the so-called "gapes" in poultry, game, and other birds; 50*l.* for the best and most complete life-history of *Strongylus pergracilis* Cob., supposed to cause the grouse disease.

No life-history will be considered satisfactory unless the different stages of development are observed and recorded. The competition is open to naturalists of all nationalities. The same observer may compete for both prizes. Essays in English, French, or German to be sent in on or before October 15, 1882, addressed to the Secretary of the Society, Chandos Street, Cavendish Square.

Development and Metamorphoses of Tæniæ.*—M. P. Mégnin now gives a fuller account of his observations than that which appeared in the 'Comptes Rendus.'† He expresses the opinion that the armed *Tæniæ*, or those which are provided with spines, are forms which exhibit a suppressed development; it is, however, to his remarks on the polymorphism of these forms that we now wish to direct especial attention. As he very justly observes, the existence of two adult forms developed from the same cestoid worm appears to be very remarkable; to remove any difficulty in accepting the correctness of his statements, he directs attention to the polymorphism which obtains [as Ehlers has shown] in *Nereis Dumerilii* and *Heteronereis fucicola*, of which one is small, agile, and free swimming, and the other large, slow, and bottom-dwelling; similar examples may be taken from among the Arachnida, and it is concluded that polymorphism is the rule in the lower animals, and that this polymorphism is always the result of the influence of the surrounding medium, or is effected by certain special conditions of existence. In the particular case now under investigation, the cause is pretty evident; when the "vesicular worm" passes into the Carnivore it finds itself in an intestine, the contents of which are in a state of continual movement so that the feeble scolex has need of all its hooks and suckers to fix itself to the wall; but, in the Herbivora, it can pass into a more retired position, and here the hooks are altogether useless.

Nematodes in the Caves of Carniola.‡ — Dr. Gustav Joseph, of Breslau, gives a brief account of his researches on the hitherto little-

* 'Journ. Anat. et Phys.' (Robin), xv. (1879) p. 228.
† See this Journal, *ante*, p. 162.
‡ 'Zool. Anzeiger,' ii. (1879) p. 275.

known free Nematodes in the caverns of Carniola. The following examples of known genera are found:—*Dorylaimus*, 2 species; *Tyleuchus*, 2; *Apheleuchus*, 1; *Tripyla*, 1; *Monhystera*, 1; *Anguillula*, 1; *Mononchus*, 1; *Cephalobus*, 2; *Rhabditis*, 3; and *Ilectus*. One species of the latter genus was especially interesting, partly because of its size as compared with *P. granulosus*, the species it most resembled (11–13 mm. as against 1·3 mm. in the male, and 9–10 as against 0·8 in the female), and partly because it was found both in the sand of the Recca-grotto and in the sea-sand near the mouth of the grotto; in other words, an animal probably originally marine is able to adapt itself to a life in fresh water and in darkness. Further observations are necessary to show whether this migration into the dark cave has relation either to wintering or to breeding.

Anuræa longispina.—This rotifer, discovered by Professor Kellicott at Buffalo, N.Y., and described in our April number,* has now been found by Mr. J. Levick † in this country, in the prolific Olton Reservoir near Birmingham.

Mr. Levick was not able to see the pair of well-defined "wheels" described by Professor Kellicott, and thinks them probably a mistake, a view which Professor Kellicott, in a recent letter to ourselves, confirms.

Studies on the Gephyrea.‡—Dr. Spengel in treating of the formation of the ova in *Bonellia*, points out that the organs described in 1852 by Schmarda as being those of the female generative system were very differently regarded by Lacaze-Duthiers in 1858; and that, since then, twenty years elapsed before the female generative organs were again carefully examined. Armed with the latest methods of modern histology, Vejdovsky has returned to the subject, while the investigations of Greef have led the latter author to confirm the results of Lacaze-Duthiers as to the uterus and ovary.

Dealing with Spengel's own observations, we find that the ovary of *Bonellia*, discovered by Lacaze-Duthiers, is placed in the ventral aspect of the animal, between the nerve-cord and the coils of the enteron; extending through the two hinder thirds of the body, the ovary is connected with the ventral blood-vessel, which accompanies the ventral cord; the anterior part of this vessel consists of a peritoneal investment succeeded by a membrane in which are contained muscular fibres; the part which takes a share in the formation of the ova is the peritoneal investment, which in its anterior portion, where it is not connected with the ovary, consists of flattened cells with small elongated nuclei; about its median third the vessel is seen to become provided with cells remarkable for their great size. These are the youngest germ-cells, or, more correctly, "primitive ova," and at the margin of each there are to be made out some flattened cells, which are so arranged as to form a kind of investment. Connected with the primitive ova is a more or less large number of cells which are placed on pedicels, and in groups which are made up

* This Journal, ii. (1879) p. 157. † 'Midl. Nat.,' ii. (1879) p. 241.
‡ 'Mitth. Zool. Stat. Neapel,' i. (1879) p. 357.

of a set of internal cells, covered by a layer of flatter ones, and both of which owe their origin to the primitive ova and their investing cells. The two sets continue to be developed equally, but the inner ones undergo a differentiation, which, it may be noted, is very difficult to observe as it is not a morphological one, but is merely dependent, in its earlier stages, on change in position; one cell becomes distinctly central and increases a good deal in size; some of the peripheral cells next increase in size; the largest cell, which results from those changes, is the future ovarian cell. Into their further history it is impossible for us, in our limited space, to follow them, and we must be content with stating that the large number of 1500 ova were found by Lacaze-Duthiers in the uterine cavity.

Passing on to the early stages in the development of the ovum we find a striking difference between the fertilized and unfertilized eggs; in the former the oil-drops are arranged peripherally and form a circle around the ovarian sphere, while in the latter the yolk is free from oil-drops and is set a good deal towards one side of the egg, while the oil-drops are limited to other parts. The first stage in fission was not observed; in the next, there were four cells of equal size, which, like the unfertilized egg, consists of two parts, in one of which all the oil-drops are collected, while the other, which contains the nucleus, only consists of a finely granular protoplasm; these two sets of structures may be known as vegetative and animal. In the next stage four small animal cells are separated off, which immediately take up a central position. The further stages of cleavage may be summed up in a few words; the animal pole having given rise to four blastomeres, continues to divide and grow over the vegetative cells, which divide more slowly. It is remarkable that this mode of cleavage has not hitherto been observed in the Gephyrea, for *Phascolosoma* has been found to exhibit equal cleavage of all the blastomeres and to form an archigastrula; nevertheless *Trochus* among the Mollusca, and *Salmacina* among the Annelids present just the same relations as *Bonellia*, and similar relations have been observed in some marine Planaria and Hirudinea; to adopt the nomenclature of Haeckel we here have to do with an amphigastrula. When the now subjacent macromeres begin to increase they give rise to the enteric epithelium; but the centre of the embryo is still occupied by the four large macromeres, which are remarkable for the possession of a large oil-drop, while the protoplasm is reduced to a fairly large investing portion, containing the nucleus on one side. When the endodermal and ectodermal cells become differentiated an orifice—the blastopore—appears; and the ectodermal cells soon pass into its inner margin. As to the mesoderm, it does not first have the appearance of two large cells, as in *Lumbricus* (Hatschek, &c.), but appears as a closed circular layer.

At this point there are some gaps in Dr. Spengel's observations, and we pass on to the characters of the embryo and of the free-swimming larva, in which we soon observe in the ectodermal cells the characteristic green pigment, together with cilia which appear on cells which are without pigment and which continue to be so. A section taken at about this stage displays a mass of

endodermal cells surrounded by a thin mesoderm which, again, is covered by an ectoderm in which, in addition to two cells, supplied with long cilia, there is a thickening of several layers of cells; this is regarded by our author as the first rudiment of the supra-œsophageal ganglion. The embryo now begins to elongate, and from the body, which is divided by the two bands of cilia into three regions, there is developed in the first and semicircular segment an eye on either side, while the whole creature takes on the form of a rhabdocœlous Turbellarian, and is seen to be possessed of a great power of contractility. The next succeeding stages appear to be somewhat difficult to follow out, and although the mesoderm is seen to divide into an ectodermal and an endodermal portion, no cœlom to speak of is immediately formed. The oil-containing cells of the endoderm give rise to a cavity and the rudiments of the œsophagus are developed. The development of the nervous system goes on at a rapid pace, but the ventral cord does not extend to the hinder end of the body, and the author was not able to observe in it the central canal reported by Greef. Great changes go on in the mesoderm; the splanchnic plate remains thin, but the somatic becomes greatly thickened, and there is, further, differentiated an external circular and an internal longitudinal layer; here ends the sexually indifferent stage of the larva, a worm-like creature, containing chlorophyll, ciliated over its whole surface and divided by two bands of cilia into three regions, of which the foremost is supplied with two large pigment spots. The enteron is a closed oil-containing sac, in which the rudiments of the œsophagus may be made out; the mesoderm is, in the anterior region, formed of a compact mass of vesicular cells, and, in the rest of the body, consists of a thin splanchnic, and of a differentiated somatic plate, in which, besides muscles, there is a mesh of tissue.

The Female of Bonellia.—The first stages in further differentiation affect the mesh of tissue just mentioned, and the indifferent cells contained in it; the changes which occur convert the "parenchymatous" larva into a "bladder-shaped worm," with a spacious cœlom, containing fluid. Whence comes this fluid? the author is not quite able to say, though he offers what he thinks is a plausible explanation. About the time when the conversion of the mesodermal cells is completed there may be seen at the hinder portion of the enteron two closed vesicles given off from the enteron, one on either side, which form, by the breaking through of their walls, a means of communication between the interior of the body and the sea-water; and the fluid is, as the author supposes, nothing more than sea-water. This change in the characters of the mesoderm does not affect the cephalic portion of it where there is, by a metamorphosis of the portion of the enteron anterior to the œsophagus, developed the cephalic lobe (or so-called "proboscis"). Passing over various points we come to the changes which take place in the epidermis; the ciliated bands, first the posterior and then the anterior, disappear, the cells of the epidermis become flatter, and dermal glands begin to be formed. The muscular bands become so arranged that the circular ones are peripheral, the oblique internal, and the longitudinal median in position. On the

ventral side and posteriorly to the mouth appear two important organs; the hinder pair consist of two setæ, each of which lies in a cellular sac, which is apparently its matrix; in front of these there is a pair of extremely delicate tubes which project freely into the cœlom, and are covered by epithelium and by a peritoneal investment; they have a narrow, although distinct, lumen. Unable to give any account of these orifices, the author regards them as primitive segmental organs; they disappear very soon. As to the generative organs, the ovaries appear very early in the form of large cells, with round nuclei, placed near the hinder portion of the ventral vessel.

The Male.—The history of the male of *Bonellia* is one of the most interesting in comparative anatomy; Schmarda, regarding the funnel of the uterus as the testis, considered that *Bonellia* was hermaphrodite. Lacaze-Duthiers considered that all the specimens he had seen were females, and Kowalevsky was of the same opinion, until in 1868 he found in the female ducts a number of small Planarian-like parasites, which he regarded as being the male form of this interesting creature. In 1877 Vejdovsky discovered (and in 1878 gave an account of his observations *) the ventral nerve-cord; Selenka has reported the presence of two sub-œsophageal ganglia and of a pair of segmental organs; while, on the other hand, Greef has lately expressed his dissatisfaction as to the reality of this Planarioid form being the male of *Bonellia*.

Dr. Spengel found the males forming green scales on the proboscis of the female, and they, when, after some difficulty, separated from it, exhibited themselves under the form of elongated small worms with a green coloured epidermis, two eyes at their anterior end, and an oily enteron—in fine they appeared to be *Bonellia-larvæ*, save only that they had lost their two bands of cilia. Further investigation showed that they possessed germ-cells, altogether similar to those of the female, connected with masses of somewhat smaller cells, arranged in a central and a peripheral group; the latter are the true seminal cells; increasing in size, they become separated from the surrounding tissue and swim about in the body-cavity of the males. Meantime the mesoderm in the anterior region becomes more compact, the rudiments of the œsophagus disappear, and the hinder portion of the enteric tract becomes fused with the mesoderm.

It is impossible here to enter into the details of the organization of the male, and we must refer in a very few words to their "morphology." The anterior portion of the body represents the "cephalic lobes" of the female, the ventral cord is essentially the same as it is in the asexual larva, but the cellular elements are not, as in the female, arranged metamerically; they form a connected cord; the digestive system is in a very elementary condition. No vascular system appears to be developed, but this is probably due to the mesodermal cells going completely to form the sperm. In conclusion, it is observed that the male of *Bonellia* is a Gephyrean in all essential points, and that, subsequently to the larval stages, all interest is centred on the male organs, while the loss of the ciliated

* See this Journal, *ante*, p. 290.

bands and of the eye-spots is to be correlated with their parasitic mode of life.

Pelagic Annelids from the Canary Islands.*—Prof. Richard Greeff describes several interesting species found by him off the coast of Lanzarote, one of the Canary Islands.

1. *Acicularia Virchowii.*—This animal attains a length of 5 to 9 mm., its greatly elongated body consisting of twenty-six to thirty-nine segments. The head-segment or prostomium is prolonged into a movable conical frontal process, which serves as a tactile organ. The head also bears a pair of leaf-like parapodia, directed somewhat forwards. These properly belong to the second segment or peristomium, but there is no separation between the two. The remaining segments bear outwardly directed parapodia, each consisting of notopodium and neuropodium, with a small prominence between them bearing setæ. The form of the two divisions of the parapodium is curious: each is more or less quadrate in outline, and attached, mushroom-like, by a stalk on the centre of its inner surface.

On the surface of the parapodia are a number of circular disks, each made up of numerous facet-like areas, like a compound eye. Further examination of these bodies shows that each consists of a deep cup-like depression of the surface, filled with a bundle of close-set parallel rods, some of which are occasionally seen projecting far beyond the surface of the disk, having evidently been partially ejected. Observation of the living animal showed that these curious organs acted as adhesive disks; they adhered to the slide and cover-slip, sometimes the whole follicle being extruded and looking like a stalked sucker. It seems probable that they may also act as urticating organs.

A description is also given of the alimentary canal, nervous system, and generative organs: a dorsal vessel containing a clear colourless fluid was made out.

The author found a larva of *Acicularia*, on the point of metamorphosing; it was chiefly distinguished from the adult by its circlet of long, outstanding setæ just behind the head.

2. *Pontodora pelagica* (*nov. gen. et sp.*).—The most interesting point about this species is the character of its segmental organs, which open by ciliated apertures at the summits of little stalked, cup-like structures on, and at the base of, the parapodia. Sometimes each cup has several ciliated apertures, sometimes only one, in which case it bears a strong resemblance to a *Vorticella*. The internal apertures of the segmental organs were not observed. The length of the body is 1·6 mm.

Greeff places *Pontodora* in the family *Syllidæ*.

3. *Pelagobia longicirrata* (*nov. gen. et sp.*).—In this species, which attains a length of 3 mm., there was no prostomium to be seen, the mouth being, to all appearance, actually terminal. There are no true peristomial cirri, but the peristomium bears, on each side, a pair of short simple feeler-like processes, and, farther back, a ciliated lobe. A pair of simple eyes, with lens and pigment, is present in this

* 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 237.

as in the former genus. It also may be placed provisionally in the family *Syllidæ*.

4. *Phalacrophorus pictus* (*nov. gen. et sp.*).—The length of the body is about 6 mm. There are two simple eyes, sessile on the extremities of the cerebral ganglion. The central lobe (Ruder) of the parapodia is ciliated, the cilia being in some places collected into bundles, which possibly represent the apertures of the segmental organs. The pharynx is provided with a pair of curved jaws. This genus is considered as an aberrent form of the *Lycoridæ*.

5. *Sacconereis Canariensis* (*nov. sp.*).—The author was prevented from tracing out the whole life-history of this species, but the probability is that, as in the species described by A. Agassiz, the impregnated egg gives rise to a sexless female or "nurse" (*Autolytus*), which, by budding, gives rise to the male (*Polybostrichus*) and female (*Sacconereis*). The female was found with her ventral nidamental pouch full of eggs and larva. Four stages of the latter are described, and also a newly discovered larva, the adult form of which is unknown.

6. *Observations on the Tomopteridæ*.—There has been a good deal of difference of opinion as to the presence of a pair of small appendages on the head of *Tomopteris*, over and above the blunt frontal feelers and the long bristled tentacles. Greeff considers that these are always present, but that they have escaped notice owing to their small size, and the fact that they are often tucked in under the head, and frequently broken off when the animal is caught. He calls them the first pair of tentacles, the well-known long setose appendages being the second.

Greeff has also investigated the "rosette-like organs," and his results are entirely opposed to those of Vejdovsky.* He fails to find anything of the nature of a lens, denies altogether the visual function of the organs, and considers them to be parapodial glands.

An account of the muscular system of *T. Eschscholtzii* is given, and the paper concludes with a description of three new species, *T. Kefersteinii*, *T. levipes*, and *T. Eschscholtzii*.

Annelid Jaws from Scotch and Canadian Palæozoic Rocks.†—Mr. G. J. Hinde describes fifty-five different forms, the greater proportion of which are from Canada, the strata in which they were imbedded being principally shallow water deposits. After referring to the very few recorded instances of the discovery of any portions of the organism of errant annelids as distinct from their trails and impressions in the rocks, he describes the principal varieties of form and of the structure of the jaws, classifying them from their resemblances to existing forms under seven genera, five of which are included in the family Eunicea, one in the family Lycoridea, and one among the Glycerea.

The jaws occur as small, dark, shining objects, very varied in form, dispersed through the rock, quite detached from each other and from the positions they occupied in the head of the animal. The material of which they are composed appears to be nearly entirely of a chitinous character, and so far free from calcareous matter that it undergoes no change in nitric acid.

* This Journal, ii. p. 155.

† 'Quart. Journ. Geol. Soc.,' xxxv. (1879) p. 370.

There is very great variation in the dimensions of the jaws; the greater number do not average more than $\frac{1}{12}$ inch in length, but a few are $\frac{1}{3}$ inch long and $\frac{1}{10}$ inch wide. In order to form an idea of the relative length of worms with similar jaws, the principal jaw-plate was measured in a specimen of the existing *Eunicea sanguinea* (whose body was 8 inches long), and was found to be $\frac{1}{8}$ inch long and $\frac{1}{15}$ inch wide. If the length of these animals is in proportion to that of their jaws, then the largest of the fossil jaws would belong to an annelid of about 13 inches in length, whilst the greater part would not be more than $3\frac{1}{4}$ inches.

Organization of Batrachobdella Latasti, C. Vig.*—This Hirudinean was found living parasitically upon a Batrachian of Algeria, *Diploglossus pictus*, which, added to a certain external resemblance, led to its being taken for *Glossiphonia algira*. Like the latter, it has only two eyes, but is otherwise distinguished by its smaller size, its more regular form, not attenuated in front, its green colour, and its proportionally larger posterior sucker. The following are the results of its anatomical study by C. Viguier.

Genital Organs.—The genital orifices are in the male on the twenty-first ring, and in the female between the twenty-third and twenty-fourth. There is no developed penis, but a simple button, as in the *Glossiphoniæ*, which is generally placed a little to the right of the median line (looked at from the lower surface). The epididymi are very large, and, after a certain number of folds, each gradually narrows into a very slender deferent canal. Twelve testes relatively large are arranged in two regular and parallel rows. The female apparatus is composed of two very small pyriform ovaries, from which start slender oviducts, passing into a very small transverse and always exactly median matrix situated immediately above the vulva.

Digestive Apparatus.—There is, as in the *Glossiphoniæ*, an exsertile trunk, behind which the œsophagus has the aspect of a muscular tube with longitudinal and annular fibres. Above the genital orifices there is a large, pyriform, brownish swelling, visible by transparent light in the living animals, and which is constituted, from without inwards, by somewhat voluminous brown cells, and by large clear cells with a brilliant nucleus, disposed all round the lumen of the digestive tube. Immediately behind this swelling, which performs, no doubt, the function of a liver, are the first lateral cæca, which pass in front of the first testes; five other cæca on each side pass between the testes of each row. Lastly, a seventh pair of narrow cæca comes behind the last pair of testes. The axial portion of the digestive tube presents between the cæca small turbid cells, perhaps hepatic cells. Behind the seven pairs of narrow cæca, and where the cavity of the body is no longer occupied by the testes, are four pairs of large cæca —the first two directed slightly forward, the third nearly transverse, the fourth directed backward. The terminal portion of the digestive tube makes a small loop to the left, and is then directed in a straight line to the anus.

* 'Comptes Rendus,' lxxxix. (1879) p. 110; 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 250.

Circulatory Apparatus.—The circulatory apparatus is nearly identical with that described by Budge in *Clepsine;* but the vascular loops of the head advance further in front of the eyes.

Nervous System.—The nervous system nearly agrees with that described by Baudelot in *Clepsine.* The sub-œsophageal portion of the collar results from a more considerable grouping, and the terminal mass of the chain from a smaller grouping than in *Clepsine.* The number of large cells contained in the vesicles attached to the ganglion is less than figured by Baudelot.

In short, *Batrachobdella* approaches the *Glossiphoniæ* or *Clepsinæ* by its nervous system and circulatory apparatus, while the general arrangement of the genital organs is rather that which is found in *Ponbdellæ* or *Pontobdellæ;* and the digestive apparatus, although presenting a trunk as in *Clepsine*, differs from what is seen in all the other Hirudineæ by the arrangement of the cæca and presence of a hepatic swelling.

New Alciopid.*—In describing the eighth species of this interesting group which is now known to constitute a portion of the Mediterranean fauna, Dr. Richard Greef calls attention to the great size of the dorsal lamellar cirri of *Alciopa Krohnii;* the dorsal, as well as the ventral cirri, are not rounded, but are continued into an elongated conical tip. As in the other species of the genus, and in connection with its pelagic mode of life, the whole body is transparent, the only exception being the red eyes beneath the first pair of dorsal cirri, and the lateral brown glands, which are so situate as to be with difficulty visible; the eyes are also separated considerably from one another, owing to the great breadth of the cephalic region. The muscular supply of the parapodia is exceedingly well developed, inasmuch as four powerful muscles pass out, on either side, from the inner face of the body-wall to these organs and break up in the cirri; one of these pairs passes so close to the ganglion as to be easily mistaken for a nerve-cord.

In the characters of its nervous system and of its sensory organs this new species agrees very generally with the other Alciopids. Special organs which appear to belong to the "segmental" series are very briefly mentioned; they form cellular tubes, very similar to racemose glands, and lie, coiled in the body-cavity, on either side of the enteric tube, while they give off a canal which appears to pass into the body; unfortunately, the author was unable to make out either their external or their internal orifices.

Organization and Classification of the Orthonectida.†—Professor A. Giard has now completed his researches on this important group of Vermes, his discovery of which was announced in a preliminary paper published in 1877,‡ reproduced in this Journal.

1. *Rhopalura ophiocomæ.*—For the generic description and mode of occurrence of this species we refer to the abstract just mentioned.

* 'Mitth. Zool. Stat. Neapel,' i. (1879) p. 448.

† 'Journ. Anat. et Phys.,' xv. (1879) p. 449, also 'Comptes Rendus,' lxxxix (1879) p. 545.

‡ 'Comptes Rendus,' October 29, 1877; see this Journal, i. (1878) p. 23.

The ectoderm of each metamere is composed of a single transverse row of large cells, of which the first and last metamere contain four each, the others, with the exception of the papilliferous zone, in which the number is not readily made out, contain six or eight each.

The endoderm forms a sac, the external surface of which exhibits the appearance of delicate muscular bands. These, the author believes, are due not to separate muscular fibres, but to processes of the endoderm cells, of the same nature as the well-known process of the ectoderm cells of *Hydra*, so that *Rhopalura* may be said to possess a *splanchnopleural pseudo-mesoderm*, while *Hydra* has a *somatopleural* pseudo-mesoderm. If this discovery is confirmed it will be one of very great importance.*

2. *Intoshia* † *gigas.*—This species is two and a half times as long as *Rhopalura*, which attains a length of 0·108 mm. The body is somewhat flattened, instead of regularly cylindrical, less produced at the ends than *Rhopalura*, with less distinct metameres and no papilliferous zone. Each segment is composed of several rows of cells, these latter being much smaller as well as more numerous than those of *Rhopalura*. No trace was discoverable of the muscular bands, although the author is inclined to think that they exist in a reduced condition.

3. *Gemmiparous Reproduction of Orthonectida.*—Under certain circumstances the cells of the endodermal sac undergo great modification, and the sac, increasing greatly in size, breaks through the endoderm, and escapes as a sporocyst. In the interior of this buds are formed, and from these secondary buds arise, sac-like bodies being finally produced, formed of one layer of cells, from which a second layer is afterwards formed by delamination.

4. *Oviparous Reproduction.*—A few developmental stages of *Rhopalura* were observed: enough to show that yolk-division is of a well-marked amphiblastic type, and that the gastrula is formed by epiboly. Caryolytic figures were observed in the nuclei of the dividing cells.

In *Intoshia* development is as markedly archiblastic: the blastula is composed of columnar cells radiating from the central cleavage cavity. The central end of each cell subsequently becomes divided off to form an endoderm cell; the inner layer arises therefore by delamination.

5. *Systematic.*—The *Orthonectida* are defined by the author as follows:—Metazoa, retaining throughout life the planula form; having a ciliated ectoderm which exhibits a division into metameres, which do not correspond with any internal division; having also a sacciform endoderm, giving rise to a splanchuo pleural pseudo-mesoderm. Reproduction (*a*) asexual, by gemmæ, and (*b*) sexual, the sexes being probably lodged in different individuals.

The group includes a single species of *Rhopalura* (*R. ophiocomæ*), and three species of *Intoshia* (*I. gigas*, parasitic on *Ophiocoma neglecta*;

* Professor Giard's figures are unfortunately not good enough to enable the reader to judge for himself of the soundness of the author's conclusions. They show nothing more than a striation of the endoderm.

† This genus should properly be *McIntoshia*, having been named in honour of Dr. McIntosh.

I. linei, on *Lineus gesserensis*; and *I. leptoplanæ* on *Leptoplana tremellaris*).

The relations of the group the author expresses in the following table:—

```
                              Cestoda.
              Turbellaria.        |
                   |          Trematoda.
                   |______________|
                          |
  Gasterotricha.    Protelmintha.        Dicyemidæ.
        |_________________|___________________|
                          |
                   Orthonectida.
                          |
                     Gastræada.
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6. The author discusses the bearing of his discovery upon the gastrula theory, and comes to the conclusion that, although the structure of the *Orthonectida* seems to support Ray Lankester's planula theory, or Metschnikoff's parenchymula theory, the primitive form of the Metazoa is the gastrula by invagination.

Echinodermata.

New Organs of the Cidaridæ.*—Mr. C. Stewart calls attention to the existence in the members of this family of five organs, each borne immediately below the outer extremities of the compasses. In form they are identical with the external branchiæ of the other families of the Desmosticha, but their walls are more delicate. The author agrees with Müller in denying the existence of external branchiæ in the Cidaridæ, and believes that the organs described functionally replace them. They are diverticula of the peritoneum-bounded chamber in which the jaws are lodged, and if their function be respiratory, he thinks the chamber must communicate with the surrounding water near the tips of the jaws. These branchiæ would then have their interior bathed with water, their free surface by the fluid of the body-cavity. It is suggested that the function of the compasses, their muscles and ligaments, is not the movement of the jaws, but to vary the capacity of the jaw chamber and so cause a renewal of its water.

In speaking of the pedicellariæ of *Dorocidaris papillata*, the frequent occurrence of four-jawed examples of the armed variety on the anal region was pointed out; also that in all armed pedicellariæ of this family which end in a single fang this is hollow, and has an opening on the outer border near the tip; at its proximal end the hollow opens into the special chamber of the jaw. The resemblance of these to the gemmiform pedicellariæ of the Echinidæ is indicated.

The existence of a series of spines projecting from the inner surface of the corona between the inner ambulacral pores is shown in *C. tribuloides* and *Phyllacanthus baculosa*; and also that in *D. papillata* the amount of spicula development in the genital gland is very variable.

* 'Trans. Linn. Soc. (Zool.),' i. (1879) p. 569.

Echini of the 'Challenger.'*—Professor Alexander Agassiz has just published a preliminary report on the Echini of the exploring expedition of H.M.S. 'Challenger.' It was not Agassiz's intention to publish this preliminary notice, as he hoped to be able to issue the descriptions of the species with his final report on the group; he found himself, however, compelled, for the sake of retaining for the material of the 'Challenger' expedition the priority of discovery, to notice, however briefly, the magnificent collection entrusted to his care by Sir Wyville Thomson.

In contrasting this collection with those made during the two expeditions of the U.S. steamer 'Blake,' Agassiz says that these latter contain some of the most interesting forms obtained by the former, often complementing more or less imperfect 'Challenger' material. Among the Cidaridæ, Arbæciadæ, and Diadematidæ many new species were found, and a new genus allied to *Astropyga*. Among the Echinothuriæ, a number of new species were dredged. Of the Echinometradæ nothing of importance was collected. Among the Temnopleuridæ excellent series of the species of *Salmacis* and *Temnopleurus* were obtained, a *Cottaldia*, hitherto only known from the chalk, and an exquisite genus *Prionechinus*, allied to *Salmacis*. The most interesting feature of the Echinidæ proper was the occurrence of several northern forms in deep water in the tropics. Not a single new species of Clypeastroids was found, and the number of specimens even was quite small. They do not play any important part in shaping the character of the fauna of deep water, and are, perhaps, the most strictly littoral group of Echini, indicative, at least in the present epoch, of comparatively shallow water, inside of the 100-fathom line, and probably giving us a good guide as to the depth of the sea and the nature of the bottom of the cretaceous and tertiary shores, where they occur in such large numbers. One recent species of *Catopygus* is interesting, as adding another of the cretaceous forms to those still living.

By far the most interesting group of Echini is that of the *Pourtalesiæ*—the species were found in abundance; of *Pourtalesia* there are six species. In *Cystechinus* there are three species, *C. Wyvillii* and *C. clypeatus* have quite stout tests, while in *C. vesica* the test is reduced to a mere film, so that even in alcohol the shape of this sea-urchin reminds one of the crown of an old felt hat which has seen its best days. The test of all the *Pourtalesiæ* is quite delicate, the amount of limestone being, at the great depths where they occur, reduced to a minimum, and yet even at the greatest depths they are found associated with Ophiurans, which are by no means wanting in lime. Among the Euspatangia, *Spatangus purpureus* occurred in the tropics at a depth of 400 fathoms, and *Echinocardium australe* was dredged at the great depth of 2675 fathoms. In Australia it is a littoral zone species. Among the Brissina two species of *Hemiaster* were obtained allied to *H. prunella*, a new species of *Rhinobrissus*, and two new ones of *Schizaster*.

* 'Proc. Am. Acad. Arts and Sci.,' xiv. (1879) p. 190; 'Nature,' xx. (1879) p. 534.

No better idea can be given of the value of this extraordinary collection than by stating that there are described in this list no less than forty-four new species. At the time of the publication of Agassiz's 'Revision of the Echini,' there were scarcely over two hundred species of Echini known, and since that time less than fifty species have been added to the list. In the specific diagnosis of the species only the principal localities are given; the details are reserved for the full report, which we believe is in good progress, many of the requisite illustrations being already engraved.

Anal Plates of Echinocidaris.*—Professor F. Jeffrey Bell draws attention to the fact that the number of anal plates in this genus is not so constantly four as the student would be led to think from the statements made by all the writers who have defined it; it was first noticed by Professor Alex. Agassiz, that a specimen of *E. Dufresnii* might have five anal plates, while Mr. Bell's observations show that the number not only varies in the species in question, but in other species also of the same group; and that the variation may not be confined to these being only one more in number, but that there may be as few as three, and as many as six, or even ten; in those examples in which there were six or ten, it is curious to note that two of the anal plates retain the characteristic form of a right-angled triangle, and together occupy about one-half the anal area. From the figures given by Professor Bell, it would seem that the variations are exhibited in nine out of fifty-four specimens examined.

In a further paper † Mr. Bell describes and figures the dentary apparatus of three species of the genus *Tripneustes*, which exhibit gradational characters of apparently considerable importance in the determination of species.

Cœlenterata.

Phylogeny of the Ctenophora.‡—Professor Haeckel has recently read to the Jena Society (16 May, 1879) an important paper on this subject; the notice has for its basis a new form of the Anthomedusæ to which Haeckel has given the name of *Ctenaria ctenophora*.

The author commences by pointing out that the morphological characters of the Cœlenterata are such as to lead to a firm belief in their common ancestry; these, which are best seen in the Hydromedusæ, have not been quite so obvious as regards the Ctenophora; the majority of modern zoologists have associated them more or less intimately with the Anthozoa, but so long ago as 1866, Professor Haeckel suggested that they were more closely allied to the Hydrozoa, and this view later observations, but more especially those now to be recorded, considerably support. The Pacific form under investigation is regarded as being intermediate between the Gemmaria-like Anthomedusæ and the Cydippoid Ctenophora; the whole result may be summed up in saying that the Ctenophora appear to have been developed from the Anthomedusæ, and especially from the family of the Cladonemidæ.

A most interesting part of the paper is a review of the more

* 'Proc. Zool. Soc.,' 1879, p. 436. † Loc. cit., p. 655.
‡ 'Kosmos,' iii. (1879) Part 5.

important homologies between the Ctenophora and the Medusæ (specially *Cydippe* and *Ctenaria*).

CTENOPHORA.		CRASPEDOTA (Cladonemida).
1. Gastric cavity	=	Umbrella-cavity.
2. Oral margin	=	Umbrella-margin.
3. Inner surface of gastric cavity ..	=	Subumbrella.
4. Mouth of infundibulum	=	Primitive simple Medusa-mouth.
5. The two lateral pouches for the tentacles	=	The two lateral pouches for the tentacles found in some Cladonemida.
6. The two lateral tentacles	=	The two lateral tentacles of some Craspedota.
7. The eight adradial "ctenophores"	=	The eight adradial lines of some Anthomedusæ.

It is also pointed out that the four primitive peri-radial canals of the Ctenophora appear to be homologous with the four peri-radial canals which are found permanently in the majority of the Craspedota; the eight adradial canals of the Ctenophora, which are formed by the division of the four peri-radial ones, are also to be found in some Cladonemida; while those pinnate branches, which are in the Ctenophora converted into genital glands, form either generative glands in some Craspedota (*Gonionemus*, *Ptychogena*) or simple glands which have no generative function (*Catablema*, *Ctenaria*).

Ctenaria ctenophora, which belongs to the family of the Cladonemida, has an ovate umbrella provided on its outer surface (exumbrella) with eight *adradial meridional costæ*, which are principally made up of rows of urticating cells, and these are the parts which are homologous with the "ctenophores" of the Ctenophora; the subumbrella has its musculature only feebly developed and passes into a delicate velum. The gastric cavity is small and is separated by a constriction from a large and pyriform apical cavity, which occupies the aboral third of the umbrella; this latter is homologous with the "infundibulum" of the Ctenophora and with the "brood-cavity" of Eleutheria. The mouth is surrounded by sixteen simple tentacles. Four simple and hemispherical gonads (generative glands) lie in the wall of the gastric cavity; four short peri-radial canals arise from the constriction between the gastric and apical cavities and soon bifurcate to form eight adradial canals which pass to the margin of the umbrella; these eight canals are provided with glandular diverticula and are connected together, at the margin, by a circular canal; with this last there are connected two peri-radial tentacles, which form two long hollow tubes, which are beset with a series of lateral filaments. From these notes it will be gathered that although *Ctenaria* presents us with nothing new, it unites in itself a number of characters, of which a part only have been hitherto observed in any one genus of the Anthomedusæ; thus it has, for example, the eight urticating costæ of *Ectopleura*, the apical cavity of *Eleutheria*, the gastric characters of *Cytæis*, the gastro-canal arrangement of *Cladonema*, and the pinnate tentacles and tentacle-pouches of *Gemmaria*.

After dealing with the important questions of the homologies of the different parts in the Medusæ and the Ctenophora, Professor Haeckel comes to a consideration of the ontogeny and phylogeny

of the latter group; as to the former point it is to be observed that cenogenetic arrangements obtain very largely; the history of the germ is compressed and simplified, owing, doubtless, in large measure to the great development of the food-yolk. The results, however, of the elaborate comparison which has been instituted between the organs of the Ctenophora and of the Anthomedusæ seem to make it highly probable that the Ctenophora took their origin in the Cladonemidæ, and had for their ancestors Hydroid polyps of the Tubularian group.

The author finally remarks that the most important ontogenetic character in the Ctenophora is that the funnel is the first organ to appear, and that from this there are given off four peri-radial canals, which, by bifurcation, give rise to eight adradial ones. It is only after this that the so-called stomach, which is invested by ectoderm, appears.

Zoantharia malacodermata of the Coasts of Marseilles.*—M. Jourdan gives a short account of his investigations into the structure of these animals, in which he points out that the walls of their body consist of three layers, (1) an external cellular layer or ectodermic; (2) a fibrous and mesodermic; and (3) cellular and endodermic.

In the ectoderm there are to be found among other structures epithelial elements which are probably sensitive and are apparently "analogous" to the chromatophore-pouches found in *Actinia equina;* the presence of neuro-muscular cells is, it may be noted, distinctly reported. The structure of the mesodermal layer of *Cerianthus* was found to be different to that of the other zoanth malacodermata; it is stated to be composed of a thick muscular layer covered in by two planes of connective tissue; there are in it smooth muscular fibres which are longitudinal in direction and are arranged in radiating laminæ; below the internal fibrous layer there is a layer of circular muscular fibres. The fibrous layer of *Calliactis* is stated to be exceptionally thick and to be traversed by permanent pores in addition to being provided with a number of spots of circular muscular fibres which seem assuredly to act after the manner of a sphincter.

The tentacles, which have the same structure as the walls of the body, are characterized by the presence of a layer of longitudinal muscles subjacent to the ectoderm; the œsophageal walls have likewise the same structure as the body-walls, but their external cellular layer is remarkable for the presence of special glandular elements.

M. Jourdan promises more detailed observations.

Blastology of the Corals.†—Dr. W. Haacke, of Jena, deals with this subject in a paper which is couched in the language of Haeckelian morphology. After pointing out the absence of any good evidence as to the metameric characters of the corals, the author states that he regards the typical form as being a simple pyramid, the base of which corresponds to the oral and the apex to the aboral end of the body of the coral "person."

* 'Comptes Rendus,' lxxxix. (1879) p. 452.
† 'Jenais. Zeitschr.,' xiii. (1879) p. 269.

The Octocoralla or Alcyonaria offer the simplest conditions; in correspondence with the eight tentacles ranged round the peristome, the gastric cavity is provided with eight "mesenterial" filaments, which form, in the oral half of the body, gastric filaments, and in the aboral, generative sarcosepta; these eight divisions are the indications of the presence of eight *parameres*, and a half of each forms an *antimere*. After a series of considerations of the results attained to by a number of observers, of which it is impossible to present any abstract, the author comes to the conclusion that the body of the Octocoralla is formed of eight unequal parameres, which are so arranged round the primary axis as to give to the body the appearance of a bilateral symmetry; but the author is careful to point out that this last application is a somewhat wide one, and that all we can justly say is that the Alcyonarian is *octamphipleural*.

The Hexacoralla offer some points of difficulty, inasmuch as the number of their divisions may reach to several hundreds in some forms, and this multiplication of secondary and tertiary systems leads to the difficult question as to whether they each correspond to a paramere; if we accept the view that each tentacle corresponds to a paramere, then if we take such a form as *Actinia mesembryanthemum*, in which there are 192 tentacles, we find that the six largest tentacles of the first cycle correspond to the six largest parameres; and that they, as well as the next succeeding cycles of 6, 12, 24, and 48 tentacles will be each of them bilaterally symmetrical (eudipleural); but as this will not apply to the sixth cycle of 96, in which the proper sarcosepts are not paired, and they consequently would be asymmetrical, it is difficult to see how the view of Koch, by which each tentacle is regarded as corresponding to a paramere, can be substantiated. To this is opposed the view of Professor Haeckel, who regards each paramere as a sixth of the coral "person," and as made of six interradial (of the second cycle) and of six times thirty-one tentacles, of which the median (peri-radial) one belongs to the first cycle, and the lateral (adradial) thirty to the 3rd, 4th, 5th and 6th cycles respectively. This view appears to recommend itself to Dr. Haacke, who finds in *Euphyllia spheniscus* the six parameres very distinctly marked out by their coloration.

In the Tetracoralla there are four parameres.

As to the development of the different groups, we know very little as to the stages, subsequent to the gastrula, in the Octocoralla; Kowalewsky's figures seem to indicate that when the eight parameres are formed, the two lateral are much the larger, and this observation shows how it is possible, although indeed the ellipse-shaped mouth would do just as well, to draw a dorso-ventral median plane through the creature; similarly, the greater length of two of the gastric filaments (Kölliker) in the Pennatulidæ, supports the doctrine of the octamphipleural character of the Octocoralla, to which we have already referred.

There is somewhat more detailed information with regard to the Hexacoralla. Lacaze-Duthiers has shown that in the gastrula there are first developed two sarcosepts perpendicular to the median plane

* Cf. Dana's 'Atlas of Corals,' pl. vi. fig. 1.

of the body; Dr. Haacke is, however, careful to point out that this "bilaterally-symmetrical" stage is not to be confounded with that which obtains in the Vertebrata, for the latter are only comparable to a single paramere made up of two antimeres set on either side of a median plane, while in the coral there are two parameres even at this stage; two new sarcosepts then appear and the larval becomes tetrapleural, and this stage is followed by the hexamphipleural stage, which is only of *short duration;* other sarcosepts are developed, and twelve can shortly be made out; hereafter, in some forms, the number of sarcosepts is increased. As to the cause of this apparent bilateral symmetry, the author considers that the dipleural form of the Vermes and other Bilateria is to be easily referred to a creeping mode of life, to locomotion in a definite direction, while the regularly pyramidal form is due to adaptation to a sessile mode of life.*

In conclusion, he points out the natural characters of the group of the Octocoralla, which never have either more or less than eight tentacles and sarcosepts; while the difficulties as to the Hexacoralla are resolved by showing that the number six recurs with sufficient constancy to justify us in believing in the arrangement having been transmitted from a six-rayed ancestor; this arrangement may, however, have become subsequently obscured by the formation of a larger number of sarcosepts.

Porifera.

Spongiological Studies.†—A paper under this title has just been published by Professor E. Metschnikoff.

1. *Development of Halisarca Dujardinii.*—Of the two Neapolitan varieties investigated, one corresponded with F. E. Schulze's description, while the other was distinguished by forming thin, soft, slimy incrustations on stones. The larvæ of the two were similar, except that that of the first was twice as large as that of the second. The spermatozoa of the adult occurred in seminal capsules with a distinct epithelial investment. The younger eggs were beset with large club-shaped processes of their substance, standing out at right angles to the surface, and completely disappearing as the egg reaches maturity. No true vitelline membrane was observed, but a thin investment to the egg existed, probably formed of endothelial cells.

Yolk-division is complete. The first four blastomeres are similar, but afterwards a distinction is observable in larger and smaller masses arranged radially around the blastocele. The latter is at first small, becoming practically obliterated at one stage of division, but latterly appears again, and increases in size, the larva then consisting of a single layer of cylindrical cells surrounding a large central cavity. In this cavity, a number of cells now appear, constituting the mesoderm; their exact mode of origin was not ascertained, owing to the opacity of the embryos. The mesoderm cells are of two kinds, ordinary, finely granular cells, and "rosette-cells," with large, highly-refracting granules: these latter are by far the more numerous and undergo rapid multiplication, completely filling up the segmentation cavity.

* Cf. Hatschek, this Journal, *ante*, p. 567.
† 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 349.

The ectoderm cells next acquire long cilia, and those in the region of one pole of the now elongated embryo, undergo a slight increase in thickness; the embryo will afterwards become attached by this, its posterior end. But the differentiation of the ectoderm into cells of two kinds is only temporary: as it further increases in size the cells once more become uniform. In the meantime the granular cells of the mesoderm increase in number, filling up large interspaces between the rosette-cells, which previously were in close contact.

The cilia next become converted into slowly moving processes, and eventually disappear, leaving the ectoderm as a layer in which the separate cell-bodies are only distinguishable by the aid of silver nitrate: the outermost layer of the cells, at the same time, becomes firm and cuticle-like.

After a pause of two days in development, the formation of the canals begins,—Metschnikoff's account of this process being of the highest interest. These cavities are formed by a grouping of the granular mesoderm cells, which become arranged side by side, around intercellular spaces, so that, in this case, the endoderm is actually a secondary product of the mesoderm.

2. *Anatomical Observations on Ascetta.*—The author was able to prove conclusively the presence of a true ectoderm, instead of a syncytium as Haeckel maintains, the contours of the cells being well brought out by silver nitrate. Haeckel's statement that the lowest sponges consist merely of ectoderm and endoderm is also denied: a distinct mesoderm was found in *Ascetta*, in the interior of the granular amœboid cells of which the spicules were found to be produced, and not in the gelatinous interstitial substance. Nothing new was made out as to the structure of the endoderm, but the observations of Haeckel and Carter as to the passage of ciliated into amœboid cells were confirmed.

3. *Embryological Observations on Calcareous Sponges.*—In *Ascetta primordialis* the process of development resembles closely that described above in *Halisarca*. A one-layered blastula is formed, and from its cells large granular mesoderm cells are produced, which accumulate in, and finally fill up the segmentation cavity. Amongst these large granular cells occur small elements with few granules, probably the foundation of the endoderm. In *A. blanca*, the formation of mesoderm cells is confined to the lower pole of the ovoidal blastula, the process having some resemblance to one of invagination. But in neither species is there any true gastrula stage; the inner set of cells forms a mere parenchymatous mass, and never a definite epithelioid layer; from this mass endoderm and mesoderm are subsequently differentiated.

In *Sycandra raphanus*, Metschnikoff confirms his own earlier and Schulze's later observation, that the ciliated hemisphere of the blastula undergoes invagination within the non-ciliated, and not *vice versâ*, as Schulze formerly believed. In the blastula, previously to invagination, a cavity was observed in the non-ciliated hemisphere, dividing the latter into two layers of cells, an internal in contact with those of the ciliated hemisphere, and an external. The former remain large, and

form the mesoderm, probably answering to the internal cell-mass of *Halisarca*; the latter become flattened and form the ectoderm.

At the conclusion of the invagination process, when the blastopore has closed up, the embryo consists of an external layer of ectoderm cells, and an external mass of large cells in which are seen the developing spiculæ. The ectoderm cells send out pseudopodia, and confer upon the whole larva the power of executing amœboid movements. While these continue no distinction between the ectoderm cells can be seen, but if the larva is irritated, by touching it with a needle, the pseudopodia are drawn in, and the cell-contours become evident, so that, as in *Ascetta*, the syncytium theory breaks down.

In *Leucandra* the developmental process is essentially the same; so that there are two types of development amongst the calcareous sponges, one represented by *Ascetta*, the other by *Sycandra*, *Leucandra*, and *Ascandra*.

4. *The Ingestion of Nutriment in Sponges.*—Metschnikoff directly observed the ingestion of carmine in *Halisarca*, *Ascetta*, and *Spongilla*, by both the endoderm and the mesoderm cells, but in neither case by the ectoderm. In *Ascetta*, also, the extrusion of particles from a spontaneously formed aperture in a cell was observed. In *Spongilla* the cells of the ciliated chambers, like those of the ectoderm, were not observed to take in nutriment; this has an important bearing on Balfour's theory.*

In *Halisarca* it was also observed that when the sponge was overfed, the endoderm cells increased to such an extent by the ingestion of carmine, that the canals disappeared entirely, and the sponge appeared like a mass of carmine, disk much shorter, containing amœboid cells, with an ectodermal investment. This phenomenon is interesting as being of the same nature as the obliteration of the alimentary canal during digestion, in certain Turbellarians.†

5. *General Remarks.*—The author mentions having found a *Spongilla* in which there was no trace of ciliated chambers, and states further that he has observed, in the young of this species, the chambers disappear, and subsequently reappear—the amœboid or parenchymatous cells undergoing conversion into ciliated cells. The conclusion deduced from this, that the "endoderm" is formed periodically from "mesoderm," and is therefore a secondary structure, is borne out by the facts of development as seen in *Halisarca* (Metschnikoff), *Aplysilla* (Schulze), and other genera, in which the embryo consists of a solid mass of parenchyma with an ectodermal investment. This lends support to the view that the true primary germ-lamellæ are the ectoderm or epiblast, and a neutral parenchymatous internal layer (lower layer cells of Vertebrata), from which latter the mesoderm or mesoblast, and the endoderm or hypoblast take their rise as secondary formations.

The author concludes with some criticisms on the gastrula theory of Haeckel and the planula theory of Ray Lankester. He considers that the stage originally succeeding the blastula (a hollow sphere of

* 'Quart. Journ. Micr. Sci.,' January 1879, and this Journal, *ante*, p. 177.
† This Journal, *ante*, p. 287.

similar, ciliated cells) was not the gastrula, but the *parenchymella*, or planula with internal mass of parenchyma, and that this arose from the blastula, by some of the cells of the latter losing their cilia and making their way into the blastocele, like the reproductive cells of *Volvox*. This theory, according to which the gastrula is a secondary larval form, is supported by the absence of a gastrula stage in the lower sponges and cœlenterates, by the fact that the gastrulæ of different animals are not homologous, and by the occurrence of pseudogastrulæ.

Development of Horny Sponges.*—Dr. C. Keller, of Zürich, records the following observations on the development of *Chalinula* made at the Zoological Station, Naples.

Multiplication is both asexual (by buds) and sexual: the breeding season being in March and April. The sexes are separate: before sexual maturity both sexes have a brownish-yellow colour; at the breeding season, the female becomes rose-red, and finally yellowish red. It takes about twelve to fifteen hours for the larvæ to escape: afterwards the sponge rapidly dies down. The egg is surrounded with a special follicular investment. Yolk-division is amphiblastic (total, but unequal): no cleavage cavity was observed.

An amphigastrula was formed with an epiblast formed of a single layer of flagellate cells, and giving rise to the adult ectoderm; and a hypoblast which forms both mesoderm and endoderm of the adult.

Protozoa.

Reticularian Rhizopods.†—Mr. H. B. Brady continues his account of the 'Challenger' specimens. The greater part of the paper is taken up with systematic descriptions of species, of which the following are new:—*Frondicularia compta*, *Flabellina foliacea*, *Ramulina globulifera*, *Uvigerina puncta* and *U. interrupta*, *Sagrina virgula*, and *S. divaricata*, *Spirillina inæqualis*, *S. limbata*, and *S. obconica*, *Planorbulina echinata*, *Globigerina æquilateralis*, *G. digitata*, and *G. conglobata*.

The part of the paper of greatest general interest is the concluding section, "Notes on Pelagic Foraminifera." The forms at present known to occur at the surface are:—*Globigerina bulloides*, *inflata*, *rubra*, *sacculifera*, *conglobata*, and *æquilateralis*; *G.* (*Orbulina*) *universa*; *Hastingerina pelagica*, do. var. *Murrayana*; *Pullenia obliqueloculata*; *Sphæroidina dehiscens*; *Candeina nitida*; *Pulvinulina Menardii*, do. var. *tumida*, *P. Canariensis*, *crassa*, and *Micheliniana*; *Cymbalopora bulloides*; and *Chilostomella ovoidea*.

As to the question whether *Foraminifera* live both at the bottom and at the surface, the author summarizes the more important facts as follows:—

1. We have positive evidence that Foraminifera do live at the bottom of the deep sea, from the common occurrence at great depths of certain forms with composite or arenaceous tests; and we have negative evidence in the same direction in the entire absence from

* 'Zool. Anzeiger,' ii. (1879) p. 302.

† 'Quart. Journ. Micr. Sci.,' xix. (1879) p. 261; see also this Journal, *ante*, p. 276.

the surface fauna of many hyaline genera which are abundant in bottom dredgings.

2. Both in *Pulvinulina* and *Globigerina* (but notably in *Pulvinulina*) species closely allied to the surface forms are found in the bottom ooze, though they never occur at the surface; amongst others, *Globigerina dubia* and *G. digitata*, *Pulvinulina elegans*, *P. Karsteni*, *P. pauperata*, and *P. favus*. Hence there is no *à priori* improbability that the other members of the same genera are capable of supporting life at the bottom.

3. A comparison of specimens of the same species, taken at the surface and at the bottom, demonstrates at least that the average size of the former is less than of the latter, and that the thickness of the cell-wall of the largest surface specimens bears no comparison with that of adult bottom specimens.

4. Nothing comparable to the thick-shelled *Orbulinæ*, still less to those with tests composed of several layers, is to be met with in the surface fauna.

5. No surface *Globigerinæ* have hitherto been obtained by means of the towing net from points on our own shores at which they are found at the bottom.

6. A fact adduced by Dr. Wallich, of some weight, as I think, namely, that *Globigerina* shells are found in the digestive cavities of *Ophiocomæ* living at the bottom at great depths.

7. The testimony of many experienced observers (Ehrenberg, Parker and Jones, Wallich, and others), that the *Globigerinæ* in the small soundings which they had for examination contained the sarcode bodies, the colour and nature of which each has described, with which statement the author's results from the material taken in the "tow net attached to trawl" generally agree.

On the whole, Mr. Brady is inclined to think that these lowly organisms may be both deep-sea and pelagic, their simple organization enabling them to live equally well at the surface and on the sea bottom.

Structure of Haliphysema Tumanowiczii.*—This interesting organism, as to the nature of which so much discussion has lately been made, has now been examined by Professor Ray Lankester, who arrives at the conclusion that *Haliphysema* is, as Mr. Saville Kent and Mr. Carter believe, a Reticularian Rhizopod, and not, as Professor Haeckel thinks, a sponge. Of the specimens examined, furnished by Mr. Kent, some were fresh, others preserved in chromic acid.

It is unnecessary to say anything about the well-known spicular test; the point of chief interest is Professor Lankester's description of the contents. These were best made out in chromic acid specimens mounted in balsam and crushed so as to crack the test and allow of the separation of the soft internal substance. The latter was found to be "a continuous mass of protoplasm, exhibiting no central cavity, and devoid of all structure." Scattered through the protoplasm are great numbers of vesicular nuclei, like those of *Pelomyxa*, and most abundant in the basal or prominent portion of the "core" of protoplasm.

* 'Quart. Journ. Micr. Sci.,' xix. (1879) p. 476.

At the distal end, the protoplasm contained bodies much larger than the nuclei, the smaller of which consisted of mere vacuolated protoplasm, while the larger were composed of granular protoplasm with a nucleus; none possessed a cell-membrane. There was evidence that these egg-like bodies multiply by division. They agree with the "ova" figured by Haeckel, and are of quite the same nature as the nucleated germs of some Foraminifera.

The protoplasm itself "has the appearance of being built up by a meshwork of fine fibrillæ, or, to put it in another way, appears to consist of denser substance, honeycombed by very small 'vacuoles,' or spaces of less dense substance."

The external protoplasm, first seen by Saville Kent, was observed in some of the preserved specimens, having been fixed by the chromic acid in the "streaming" condition on some of the spicules. Nuclei were sometimes found imbedded in it, so that these evidently are carried out of the test in the stream of protoplasm.

Professor Lankester concludes as follows:—"From the preceding account it appears that the structure of *Haliphysema* is not quite so simple as that which has been supposed to characterize the body-substance of the Lituolida. It seems to me very possible that we shall continually find among the larger members of the various groups of organisms classed as 'Foraminifera' as high a structural differentiation as that exhibited by any of the naked fresh-water forms of Gymnomyxa (Rhizopoda), such as *Pelomyxa*, *Chlamydomyxa*, and *Actinosphærium*. Possibly when means are taken to overcome the difficulties of observation presented by their opaque and resisting shells, the larger 'Foraminifera" may prove not only to be nucleated, but to be as highly organized (though not in the same way) as the Radiolaria."

Professor Lankester seems to doubt Mr. Kent's suggestion that the organisms from which Haeckel's beautiful figures of *Haliphysema* were taken, are "remarkable isomorphs or external facsimiles of the Foraminiferal type."

Observations on New Infusoria.*—Dr. Aug. Gruber gives a short preliminary notice of some new forms, which appear to be of great interest, and of which he promises more elaborate details.

Three of the new forms occupied ramified tubes; these creatures are called *Stychotricha socialis*, *Oxytricha tubicola*, and *Maryna socialis* (gen. nov. et sp. nov.); the two former belong to the hypotrichous, and the third to the holotrichous division of the Infusoria: the author points out that they exhibit considerable analogies to the colonial forms described by Stein as existing among the Flagellata. *Tillina magna* (n. g. et n. sp.) exhibits the same processes of division as were observed by Stein in *Colpoda cucullus*. The two new marine forms which belong to the genus *Cothurnia* (Vorticellidæ) are respectively remarkable, (1) *C. socialis* for a very primitive mode of forming colonies — the new individuals formed by fission always remain attached by their long stalk to the investments of the older forms, and they are all remarkable also for the formation of a special peristomial operculum; (2) in *C. operculata* there is also an operculum

* 'Zool. Anzeiger,' ii. (1879) p. 518.

which is specially remarkable for the attachment to it of a delicate membrane which arises from the hinder part of the animal, and is able, when the animal contracts itself, to shut down the operculum of the shell.

Influence of the different Colours of the Solar Spectrum on Infusoria.*—Señor Serrano y Fatigàti has instituted experiments on this subject with results agreeing with those of M. E. Yung † in the case of the ova of frogs, fish, &c., viz. that the violet rays accelerate and the green rays retard the development of Infusoria.

Supposed new Fresh-water Species of Freia.—See 'Proceedings,' p. 989.

Lithamœba discus, a New Rhizopod.—This interesting form is described by Professor Ray Lankester,‡ who discovered it in some water sent him by Mr. Bolton from the Olton Reservoir near Birmingham.

The body is discoid, and has a diameter of $\frac{1}{125}$ inch. In the protoplasm of which it is composed are imbedded a great number of highly refracting, often uniform, concretions, the largest of them $\frac{1}{750}$ inch in length, but most of them not more than a quarter of that size. The composition of these curious bodies was not made out; they were not affected by dilute acetic acid or potash, but were dissolved by strong hydrochloric acid. Probably they are of similar nature to the granules of *Amœba*.

There is a single large nucleus, $\frac{1}{800}$ inch in diameter, of an irregularly trapezoidal form, and enclosed in a distinct membrane. It consists of a ground-substance, with a number of angular granules imbedded in it.

Included food materials—diatoms, &c.—were observed in the protoplasm, the centre of which is occupied by a very large contractile vacuole $\frac{1}{310}$ inch in diameter; a portion of the contents of this "are discharged periodically to the exterior." The vesicle does not entirely collapse, but divides into two smaller ones, which afterwards enlarge and fuse together.

The protoplasm exhibits a distinct vacuolar structure, especially well seen by treatment with osmic acid and picro-carmine. In this it resembles Greef's *Polomyxa*.

The application of iodine brings out the presence of a fine cuticle, so fine that it is ruptured by the extrusion of the pseudopodia. These are very interesting: their protrusion begins "with a minute rupture of the cuticle. Through the orifice thus produced the fluid protoplasm exudes in a spherical form, and as it increases in quantity the rupture of the cuticle is increased, whilst concretions from the more central portion of the disk-like body flow into the enlarging lobe. With great rapidity the whole extrusion appears to fuse once more with the disk, and a new rupture or extrusion takes place at another point of the margin. A new cuticular pellicle must be formed very

* 'An. Soc. Esp. Hist. Nat.,' viii. (1879) (Actas) pp. 42–3.
† This Journal, *ante*, p. 138.
‡ 'Quart. Journ. Micr. Sci.,' xix. (1879) p. 484.

rapidly on the surface of the hernia-like extrusions of protoplasm." No filamentous pseudopodia were observed.

The characters of the nuclei and cuticle are quite peculiar, and altogether *Lithamœba* takes, Professor Lankester considers, a very distinct position among the amœboid Gymnomyxa.

New Moneron.*—M. Schneider describes a new form of this interesting group under the name of *Monobia confluens*, which he has found in fresh water.

In its simplest form, in a state of repose, it forms a small and almost spherical mass of fine granular protoplasm, which has a bluish hue by transmitted light, and is provided with neither nucleus nor vacuole (Plate XXVI, Fig. 1). From this homogeneous body radiate in all directions pseudopodia of extreme delicacy, and about four times as long as it, and so transparent and fine as to be almost invisible but for the small swellings, which are placed here and there on them, and which refract the light more strongly. These pseudopodia are rectilinear, move slowly and coalesce at their extremities, so that they recalled to the author the similar processes in the Foraminifera.

When the creatures become active they lose their spherical form and move about by a general contraction of their bodies. The form which they then take varies much less than in other Protozoa; it is usually that of a Savoy biscuit inflated at the ends and slightly contracted in the middle, the extremities being the seat of the emission of the pseudopodia (Fig. 4). Sometimes they become triangular, when the pseudopodia radiate from each apex; or, again, they may become much more irregular and give off processes from every protuberance (Figs. 3 and 5).

The creature was never observed taking in food, but foreign bodies were often observed in somewhat great numbers in its interior, and these were sometimes contained in a vacuole of digesting matter, though no *proper* contractile vacuole was ever present.

When nutrition has effected a considerable increase in the size of the body, growth gives place to reproduction, which is thus effected: the body elongates and there appears a central constriction, which, getting narrower and narrower, finally disappears altogether, so that there are two individuals instead of one; but this does not happen very frequently; in most cases the two spheres remain united (Fig. 2), and a second means of communication between them, parallel to the former, is often effected by the fusion of two of their pseudopodia. As often as this relation is established, the bond of union widens by afflux of plasma and the granules of each body pass into that of the other, and the process thus begun may be continued until at last we may get an association of eight, as shown in Fig. 7; nor do the variations end here, for as M. Schneider expresses it, "the next day each member of the colony had pulled upon the common cord and a new resultant had been produced from these opposite caprices. My Monera were now grouped as drawn in Fig. 8, in a square surmounted by a triangle, the latter surmounted by an arrow."

* 'Arch. Zool. Exp.' (Lacaze-Duthiers), vii. (1878) p. 585. Fig. 6 of the Plate is not described in the text.

The colony was never the same at the end of the day as it had been at the beginning. No other mode of reproduction than that by fission was observed.

Dealing with the systematic position of *Monobia*, the author remarks that it might be as justly placed with the Foraminifera as *Myxodictyum sociale*, which Professor Claus has relegated to that class; he, however, bears in mind the almost general presence of a nucleus in the Foraminifera, and concludes that, until our knowledge of the mutual relations of the Protozoa is more complete, it is necessary to retain Haeckel's group of the Monera.

Eozoon Canadense.*—Professor Möbius replies in detail to Principal Dawson's criticism of his Monograph (see p. 275), and it is needless to say adheres to his original view. He points out more particularly that not a single one of all the specimens of *Eozoon* which he studied came from the hands of "dealers or injudicious amateurs" as suggested, but all directly or indirectly from Messrs. Dawson and Carpenter, and promises that if he is furnished with other specimens which Principal Dawson recognizes as the genuine representatives of *Eozoon*, and showing the organic nature contended for, he will examine them with care and conscientiousness, and if he finds a true organic structure will avow it without hesitation.

BOTANY.

A. GENERAL, including Embryology and Histology of the Phanerogamia.

Development of the Embryo of Phanerogams.†—Famintzin has undertaken a close investigation of this subject, with especial reference to the following statements of earlier observers (in particular Hanstein and Westermeier), viz. "That the three primary layers, the dermatogen, periblem, and plerome, show no clear separation in their products of division, but pass over into one another at their boundaries; and that a uniform origin of these three primary layers in the embryo occurs only in the tigellum (the hypocotyledonary portion of the stem), and then only in Dicotyledons; while in the whole of the embryo of Monocotyledons, and the cotyledonary portion of Dicotyledons, a more or less indefinite, and in many cases altogether irregular, cell-division takes place, without any trace for a considerable time of a separation into primary layers; and that it is only at a later period that such a differentiation can be recognized." This statement Famintzin finds must be considerably modified. His observations were made chiefly on *Capsella bursa-pastoris* and *Alisma plantago;* his main results, as far as regards these plants, being as follows:—

1. In the embryo of both these plants, the results were altogether the same as to the independence and origin of the three primary layers. In both a perfect regularity was observed in their origin; when once differentiated, the three layers remained perfectly distinct during the whole period of the development of the embryo, never

* 'Am. Journ. Sci. and Arts,' xviii. (1879) p. 177.

† 'Mém. Acad. Imp. Sci. St. Petersbourg,' xxvi. (1879) No. 10.

passing over the one into the other. Although minor differences were observed in the course of development even in the same plant, the final result was the same; that the first separation of the three primary layers is brought about in this way, that in an optical transverse section of the embryo each of its constituent quadrants appears to be composed of an inner plerome-cell, two periblem-cells, and two dermatogen-cells.

2. The second important result, both in *Alisma* and *Capsella*, is that the cotyledons—as to whose foliar nature no doubt has been entertained—cannot be regarded, as is the case with the other foliar organs, as outgrowths of the dermatogen and the periblem of the axial portion of the embryo. The cells from which the three primary layers which compose them originate, are of altogether equal value with those of the axial portion. In both plants the two inner of the primary layers do not originate by outgrowth from the layer already formed and differentiated in the axial portion, but by division, by walls parallel to the surface, of the layer which lies beneath the dermatogen in the upper half of the embryo. The divisions which give rise to the three primary layers, as well as those which afterwards arise in these layers, are altogether of equal value in both parts of the embryo, and correspond with one another.

3. The first division walls in the embryo of *Alisma* are transverse, and are formed successively in strictly basipetal order. To the first three walls the three principal portions of the future embryo—the cotyledon, the central portion, and the root—owe their origin, and they remain completely differentiated during the whole course of its development. The uppermost cell gives birth to the cotyledon, the second to the central portion, on which the stem-bud (plumule) is formed, the third to the root; by the transverse divisions which follow, the hypophysis and a portion of the pro-embryo (suspensor) are formed.

4. The place of origin was accurately determined by the detection of two dermatogen-cells in the central portion of the embryo, which were readily distinguished from the other superficial cells of this layer both by their form and by the divisions which occur in them.

5. In *Capsella* the differentiation of the tissue in the growing cotyledons in the earliest stages of their development, and the cell-divisions in the pro-embryo, must be regarded as new.

Development of the Embryo-sac of Angiosperms.*—M. Vesque, in a further communication on this subject, considers that the recent discovery of Strasburger fills up a space which previously appeared to separate Phanerogams from Vascular Cryptogams. According to the recent observations of the author, the primordial mother-cell of the embryo-sac, as defined by Warming, divides, by transverse septa, into two, three, four, or five special mother-cells, the homologues of the mother-cells of the pollen of Phanerogams, or of the spores of Vascular Cryptogams. These septa are formed in succession from below upwards, or from above downwards, according as the primordial

* 'Comptes Rendus,' lxxxviii. (1879) p. 1359; and 'Ann. Sci. Nat. (Bot.),' viii. (1879) p. 261.

mother-cell does or does not exhibit an apical increase during the formation of the walls.

The groups of Fluviales, Ranunculaceæ, and Cruciferæ present two special mother-cells; three have been observed in the greater part of Monocotyledones and Apopetalæ; four or five in Gamopetalæ, Santalaceæ, Aristolochiaceæ, &c.

The observations of the author lead him to apply the term embryo-sac to the collection of cells which proceeds from the primordial mother-cell.

In certain Liliaceæ, such as *Lilium*, each of the special mother-cells produces, by the division of its nucleus, a tetrad of nuclei which are the homologues of pollen-grains and of macrospores. The septum which separates the first and second cells becomes resorbed before the division into tetrads commences. The single cavity which results (the *embryo-sac* properly so called) finally encloses eight free nuclei which behave in the way that Strasburger has described. In the remaining Liliaceæ, *Agraphis*, *Muscari*, &c., the first and second cells alone give birth to four nuclei, while the lower special mother-cells produce an apparatus to which M. Vesque has given the name *anticline*. In *Lachenalia*, on the contrary, the first cell alone gives rise to a tetrad; three of its nuclei form the sexual apparatus; the fourth unites itself with the undivided nucleus of the second cell and coalesces with it.

The Amaryllidaceæ, Iridaceæ, Aroideæ, Juncaceæ, Cyperaceæ, &c., differ but little from the common type of Liliaceæ, which occurs again very commonly in the Apopetalæ, as in the Euphorbiaceæ, Papaveraceæ, Rosaceæ, and allied families.

The exception presented by Monocotyledones, among which the presence of a single tetrad has been established, occurs frequently among Apopetalæ—in Saxifragaceæ, Onagrariaceæ, &c.—and becomes, so to speak, the rule among Gamopetalæ; while Caprifoliaceæ and Valerianaceæ do not present this character, and thus offer a greater resemblance to ordinary Apopetalæ. The first cell always produces a complete tetrad, even in the most highly organized Gamopetalæ, such as Compositæ.

The cells to which the author gives the name of *anticlinal* present remarkable differences in their development. Sometimes they are arrested immediately after their development (*inert anticlinals*); sometimes they increase and divide after impregnation, and thus produce the albumen (*active* or *albuminigenous anticlinals*), as in Ericaceæ, Scrophulariaceæ, Labiatæ, &c.; sometimes again they elongate and ramify in order to reach, in the tissues of the chalaza or even of the placenta, as in *Osyris*, &c., the nutritive substances which they bring to the other anticlinals to enable them to divide (*cotyloid anticlinals*). The part which the development of the albumen takes in the production of the special mother-cells suggests a comparison with the prothallium of Vascular Cryptogams. This remark applies also to the albumen which is formed in the first and second cells by the division of the central nucleus, whether the multiplication of the nuclei be accompanied by the simultaneous formation of septa, as in Plantagi-

naceæ, Compositæ, &c., or whether the septa appear only at a later period, as in Ranunculaceæ.

From these considerations, the mature embryo-sac may be classified under four types:—

1. Embryo-sac consisting of two special mother-cells; two tetrads; antipodals without anticlinals (Fluviales, Ranunculaceæ, Cruciferæ, &c.).

2. Embryo-sac consisting of three or four special mother-cells; two or more tetrads; antipodals; one or two inert anticlinals (the greater part of the Liliaceæ and allied families; Euphorbiaceæ, Papaveraceæ, Rosaceæ, Caprifoliaceæ, &c.).

3. Embryo-sac consisting of three or four special mother-cells; a single tetrad; no antipodals; one or two inert anticlinals (Onagrariaceæ, Saxifragaceæ, Boraginaceæ; Primulaceæ; Apocynaceæ; Compositæ, &c.).

4. Embryo-sac consisting of four or five special mother-cells; a single tetrad; no antipodals; one or two active anticlinals; an inert or cotyloid anticlinal (Aristolochiaceæ, Santalaceæ, Scrophulariaceæ, Labiatæ, Ericaceæ, &c.).

Angiosperms and Gymnosperms.* — Professor Strasburger has supplemented his previous researches on this subject by a publication of great importance. Owing to a change of view as to the homology of the ovule in Gymnosperms, the terms for the two great classes previously suggested by him, Archisperms and Metasperms, are now abandoned. The main results at which he has arrived may be summed up as follows:—

The points which have specially engaged the author's attention are the development and homology of the ovule in Angiosperms and Gymnosperms; the origin of the embryo-sac, and the processes that take place in it before impregnation; the formation of endosperm; the structure, development, and homologies of the flower and inflorescence in Gymnosperms; and some questions as to fertilization and the formation of the embryo in the same class. He is able to confirm his previous observations on the development of the embryo-sac and the processes which take place in it in the case of *Monotropa* and the Orchideæ, and considers them to be of general application. He disputes Warming's and Vesque's † statement that the two or four cells formed by the septation of the mother-cell of the embryo-sac ever coalesce into a single cavity; it is only one of these cells, usually the lowermost, that develops into the embryo-sac, pressing aside its sister-cells. The germinal apparatus and the antipodal cells are formed in the same way in the embryo-sac; there is never any formation of tetrads in the sister-cells. Strasburger also disputes Vesque's assertion that antipodal cells are not formed in many Gamopetalæ. These assertions are illustrated and proved by a large number of drawings. The author does not agree with the view of Warming and Vesque that the cells formed by the division of the mother-cell of the embryo-sac are

* 'Die Angiospermen und die Gymnospermen,' von E. Strasburger, Jena, 1879; see 'Bot. Zeit.,' xxxvii. (1879) p. 514.

† See this Journal, *ante*, p. 904.

homologous to pollen mother-cells, and supports his contrary opinion by cogent arguments. He would rather find a homologue to the pollen-grain in the embryo-sac itself.

As to the homology of the ovule, Strasburger abandons his earlier view that it is a bud; he would now rather compare it to a sporangium. In the details of the comparison he does not, however, agree with Warming, but considers the funiculus as the homologue of the pedicel of the sporangium, the nucule that of the capsule itself. In this connection he investigates the phenomenon of oolysis in *Rumex* and *Helenium*; and comes to the conclusion that it is not, as generally supposed, a phenomenon of reversion. The fact that in these cases leaf-pinnæ finally appear in place of the ovules which spring from separated carpellary structures, and buds in place of the terminal ovules, he regards as a substitution of one structure for another, vegetative organs being produced instead of reproductive. Since the two processes compete with one another, a variety of intermediate forms make their appearance, according as one tendency or the other preponderates. If oolysis were really a reversion phenomenon, it might be expected that a structure would sometimes be formed resembling the sporangium of a cryptogam; while, on the contrary, the result is always the production of purely vegetative leaflets, or of a bud. The conception of the ovule as the homologue of a sporangium is confirmed by many facts; such as the position of the ovules, in certain plants, on the median line instead of the edge of the carpel, and their occasionally unquestionable origin from the axis of the flower.

With respect to the relationship of the ovule to the pollen-sac, the author maintains that in this case there is no homology; malformations never show a single ovule, but always a considerable number, in place of an anther-lobe; so that this latter may be regarded as homologous to a sorus.

In the latter portion of his treatise Strasburger enters into a detailed account of the structure and development of the female flower in the Coniferæ and Gnetaceæ; and he now regards as ovules the structures previously described by him as ovaries. The investigation of the history of development of the ovule leads him to the important conclusion that the mode of formation of the embryo-sac in Gymnosperms agrees in essential points with that in Angiosperms. As in these, the mother-cells of the embryo-sac arise from the cell-layer immediately beneath the epidermis, and from the first step in division. Inner cells become the mother-cells of the embryo-sac, while the outer ones may be regarded as "Tapetenzellen" of Warming. The mother-cells, whether formed singly as in Abietineæ, or in numbers as in Taxaceæ, are each divided by septa into three cells; the lowermost of each now becomes the embryo-sac, and supplants the other two.

The ovule of Gymnosperms, notwithstanding some not unimportant differences, is unquestionably homologous, in its first stages of development, to that of Angiosperms. The processes that take place in the embryo-sac are also comparable in the two cases. In Angiosperms the nucleus divides, and its derivatives pass into the ends of the embryo-sac, where four nuclei take the place of the original one.

The processes in the embryo-sac of Gymnosperms also commence with a division of the nucleus; after which appears the first difference, namely, that the septation continues, instead of ceasing when four nuclei have been formed in each end of the embryo-sac. But after impregnation the formation of endosperm begins afresh by cell-division or division of the nucleus. Strasburger is inclined to regard the cells of the germinal apparatus and the antipodal cells as endosperm-cells; the germinal cell appears to him to be a very reduced archegonium.

With regard to the relationship of Gymnosperms to Vascular Cryptogams, Strasburger is disposed to look on the former as directly descended from the Lycopodiaceæ. The genetic connection of Angiosperms with Gymnosperms he considers much more doubtful; but is unable to regard the Gnetaceæ as the ancestors of the former.

Investigations on the process of fertilization, especially in *Juniperus virginiana*, resulted in the detection of a canal-cell, previously overlooked in the Juniperaceæ, originating only very late, at the commencement of impregnation, and very soon becoming disorganized.

The formation of the embryo in *Cephalotaxus* and *Araucaria* presents several remarkable peculiarities. Among others, the apex of the rudiment of the embryo consists of large cells containing but little protoplasm, which form a kind of protective apparatus, and are afterwards thrown off. The apex of the stem is therefore formed from inner cells.

Nucleus of the Embryo-sac.*—In his 'Cell-formation and Cell-division,' Strasburger states, as a universal rule, that no fresh formation of nuclei takes place in the embryo-sac; all the nuclei proceeding from one another by division. According to Darapsky, an exception to this rule occurs in the case of *Hyacinthus ciliatus*, where the large size and great clearness of the nucleus in the embryo-sac when in a state for fertilization present favourable conditions for observation. During the development of the endosperm in this plant, the fresh formation of nuclei for the cells of which it is ultimately composed can be readily observed.

Gymnospermy of Conifers.†—A contribution to the literature of this subject is furnished by Celakovsky, in a description of a proliferous fir-cone carefully examined by him.

The rachis of the cone was produced into a terminal shoot, the internodes of which were moderately elongated, and the scales much smaller than in the ordinary cones, and exhibiting transitions to axillary buds. Near the apex was a dense rosette of large, leafy buds arranged in several spiral rows. Above this were several whorls of sterile acicular leaves, and finally a leafy spiral terminal bud consisting of ciliated bracts. With respect to the position of the ovules on the fertile scale or on the two bracts of the bud, the abnormal structures show beyond a doubt that they spring from the back or under side of the bracts; and a careful examination proved that the origin of the ovule was clearly in the channel-like depression

* 'Bot. Zeit.,' xxxvii. (1879) p. 553.

† 'Flora,' lxii. (1879) p. 257.

between the rolled-in margin and the median line of the entire fertile scale. The position of the ovule on the back of the bract in the bud shows that it cannot possibly be an axillary shoot to this bract. Another corroboration of the ovular theory and gymnospermy of Conifers is that, as far as has at present been observed, the ovules, in retrograde metamorphosis, never develop into shoots, but begin to disappear as soon as the metamorphosis commences.

The general result of Celakovsky's observation is—in opposition to the earlier view of Strasburger—to confirm the prevalent theory that the ovule of Conifers is truly gymnospermous.

Reproductive Organs of Cycadeæ.*—In sequel to his observations published in 1877, M. Warming has re-examined the subject with fresh material. The principal results before arrived at are fully confirmed; but he now considers that both Strasburger and himself were in error in the supposed observation of a canal-cell to the "archegonium"; what he previously described as such he now believes to be a large nucleus of the central cell which descends towards its lower extremity. M. Warming also confirms the remarkable observation that in *Ceratozamia* the embryo is never formed in the seed until after having been sown in the soil. The embryo has only a single cotyledon, which is unilateral, and embraces the summit of the stem; the radicle and the tigellum are very short in proportion to that of the pro-embryo; their structure appears to be identical with that of Coniferæ.

True Mode of Fecundation of Zostera marina.†—According to M. A. Clavaud, it is not correct, as generally supposed, that the anthers fertilize the pistils of flowers enclosed in the same spathe, these organs not being nearly mature at the same time. There is dichogamy and proterogynous dichogamy. Neither is the assertion correct that the extremity of the pollen-cell penetrates into the ovary through a stylar canal open at the summit of the stigmatic branches. This apical opening does not exist, and the extremity of the pollen-cell is inert. The pollen-tube does not grow from the terminal elongation of the pollen-grain; it is always a lateral swelling situated at a certain distance from this extremity, which, when applied to any point of the stigmatic surface, penetrates by means of a notable "gelification" of the walls, which produces later the destruction of the stigmata.

Arrangement and Growth of Cells.‡—Professor Sachs has been pursuing his investigation of these difficult subjects in the Botanical Institute at Würzburg, and contributes a further instalment of results.

The chief point which he desires to bring forward with respect to the growth of cells is that the normal direction for the formation of a new wall is always at right angles to that from which it starts, and

* 'Bull. Acad. Roy. Copenhague,' 1879, p. 73; French résumé, p. 9.

† 'Acta Soc. Linn. Normandie,' ii. p. 109; 'Bull. Soc. Belg. Micr.,' v. (1879) p. 197; see 'Bot. Zeit.,' xxxvii. (1879) p. 535.

‡ 'Arb. Bot. Inst. Würzburg,' ii. (1879) p. 185.

that in the less common but still numerous cases in which the direction is different, this is always the result of disturbance. Division at right angles appears to be a common property of the protoplasm of cells in a condition to divide; and this would seem to be a fact of fundamental importance, although we are altogether in ignorance as to its cause. Whenever an apparent departure is witnessed from this law, it must be the result of forces at work during the division, which deflect the wall from its normal direction. The essential factor in all growth is the increase in volume of the organ on the one hand, and its change in form on the other hand.

With respect to the formation of cells, the author refers to a view which he has already previously expressed, that many organs which have ordinarily been described as unicellular, are in reality not cellular at all. This is especially the case with the Cœloblastæ. The ends of the shoots of *Caulerpa*, *Mucor*, &c., play the same part in these plants as the cellular growing point in the higher plants; and the same is the case with the ends of the shoots of *Codium* and of the fruticose lichens. The Sphacelariaceæ present a beautiful passage between the truly cellular and the non-cellular plants. In this group the whole of the growing part of the plant is non-cellular, and the apical cell corresponds to the earlier growing end of the shoot in higher plants. The formation, growth, disappearance, and new formation of growing points are a consequence of distribution of growth; the growing point is, however, not the only, although a very common manifestation of this distribution.

Various Forms of the Cell-nucleus.* —At the conclusion of his paper on "Cell-formation and Cell-division," Professor Strasburger thus sums up the main results arrived at.

The processes of division are identical in animal and vegetable cells; as also is the behaviour of the nucleus, with unimportant deviations. The greatest variation which has at present been observed in the division of the nucleus is that between the "nucleus-spindle" with differentiated disk, and the "nucleus-barrel" without any differentiated disk. The "nucleus spindle," exclusive of the disk, is composed of slender threads usually converging towards the poles; the "nucleus-barrel" of stronger threads of one kind only, and only slightly approximating towards the poles. The various special forms are classified as under, viz.:—

I. "Nucleus-spindle"; with differentiation into "threads" and "disk."
  1. The threads converging strongly towards the poles.
    a. The poles clearly marked.
      α. The elements of the "plate" uniformly distributed in the equatorial plane of the "spindle." Many animal ova.
      β. The elements of the "plate" more or less regularly distributed in the equator round the "spindle." Endothelium of the frog.

* 'Bot. Zeit.,' xxxvii. (1879) p. 281.

b. The poles not clearly marked.

α. The elements of the "plate" distributed regularly in the equatorial plane of the "spindle." Most vegetable cells.

β. The elements of the "plate" lying outside the "spindle" in the equator. An unusual case in the integuments of the ovule of *Nothoscorodon fragrans.*

2. The threads only slightly or imperceptibly converging towards the poles.

a. The ends of the threads marked by knots. Embryo-sac and integument of *Monotropa.*

b. The ends of the threads not especially marked. *Spirogyra.*

II. "Nucleus-barrel" formed of a single kind of rod-like elements.

1. The elements of the "barrel" strongly converging towards the poles. Integument of ovule of *Nothoscorodon fragrans.*

2. The elements of the "barrel" only slightly or imperceptibly converging towards the poles. Epithelium of larva of salamander; cartilage of larva of batrachia.

Conducting Tissue for the passage of Pollen-tubes.* — The structure and development of the tissue which serves the special purpose of conducting the pollen-tube from the stigma, through the style and ovary to the micropyle of the ovule, has been made a special subject of study by M. G. Capus.

By a conducting tissue the author understands one composed of cells, usually elongated, delicate, and but slightly united, the union of which forms a cylinder occupying the centre of the style, or lining the walls of a central stylar canal. The pollen-tube carries on a parasitic existence, obtaining the nutriment necessary for its rapid elongation from this conducting tissue. The development of this tissue hence depends greatly on the number of pollen-tubes for which it is destined to supply the nutriment, and therefore on the number of ovules to be fertilized.

This conducting tissue is always a modification and extension of the epidermis, whether on the surface of the stigma itself, as a lining to the stylar canal, or on the walls of the ovary or of its dissepiment intermediate between the base of the style and the ovules. At the period of impregnation the cells of this tissue are filled with a dense, granular, oily and nearly opaque substance. In certain cases the periblem or hypodermal tissue takes part, along with the true epidermis, in the origin of the conducting tissue. Again, but rarely, the conducting tissue may owe its origin to prolification, or the tangential division of the epidermal cells; more often to a similar division of the hypodermal cells. The stigma, properly so called, is nothing but the apical termination of this conducting tissue of the style.

In the ovary it is never continued below the spot from which spring the lowest ovules. It is much more strongly developed in ovaries with parietal placentation and a large number of erect ana-

* 'Ann. Sci. Nat. (Bot.),' vii. (1879) p. 209.

tropous ovules than in those with parietal placentation and a small number of pendent anatropous ovules, or in unilocular ovaries with a single erect orthotropous ovule. In almost all cases the pollen-tube has to traverse a longer or shorter free space between this conducting tissue, where it is in the immediate proximity of the placenta, and the micropyle of the ovule; and the cause of this deviation of the pollen-tube from its previous course is altogether unknown. The conducting tissue of the placenta is frequently raised in the form of more or less prominent papillæ or hairs; and the same is the case with that of the stigma and even of the style.

The style may be either hollow in the centre, the cavity being then lined by the conducting tissue, or it may be solid, the central portion being then loose and large-celled, and forming itself the conducting tissue. Most commonly ovaries with parietal placentation are terminated by a hollow style. In plurilocular ovaries with axile placentation, there are frequently a number of separate stylar canals corresponding to the number of loculi.

The cells which form the conducting tissue do not always remain united into a compact continuous tissue; those which line the stylar canal frequently become detached over a smaller or larger extent of the surface, and produce a kind of soft jelly. The cells of the conducting tissue frequently contain starch, oil, and amorphous chlorophyll. The pollen-tube traverses the style either within the conducting tissue, or in immediate contact with it, or with its papillæ, drawing its nutriment from its cells. The stigma, even when apparently terminal, is always really lateral, and formed from the edges of the carpellary leaf rolled over and meeting. In the same manner there is a double formation of conducting tissue for every carpel within the ovary; and in those cases where the style is solid, it is formed by the coalescence of the opposite edges and sides of a primitive canal.

Seminal Integuments of Gymnosperms.*—M. Bertrand publishes an exhaustive paper on this subject, in which he sums up the present state of our knowledge under the following heads:—

(1) Ovules of Gymnosperms. He here discusses the orthotropy of the ovules of Gymnosperms; the number of their integuments; their development; their "pollen-chamber"; their vascular system; and the morphology of their different parts. (2) The transformation of the ovular into seminal integuments; including the closing of the micropylar canal; the formation of the membranous seminal integuments; the formation of the partially fleshy and partially woody, or partially dry and partially woody integuments; and the arillus. (3) The disposition of the seminal integuments in the principal genera of Gnetaceæ, Coniferæ, and Cycadeæ. (4) The accessory envelopes and disseminating organs of the seeds of Gymnosperms. This includes an account of the accessory envelopes in *Welwitschia*, *Ephedra*, *Gnetum*, Coniferæ, and Cycadeæ; and of the direct and indirect organs of dissemination in the various families. The paper is illustrated by six plates.

* 'Ann. Sci. Nat. (Bot.),' vii. (1879) p. 61.

Relationship of Intercellular Spaces to Vessels.*—Dr. Von Höhnel points out that one important functional difference between true vessels and intercellular cavities is that, while in the latter the pressure of the air never differs materially from that of the surrounding atmosphere, in the former it may either be considerably less (when transpiration is very active), or in some cases more than double as great. Except in a few special instances, the fibrovascular bundles consist of vessels in close apposition with one another, without intercellular spaces.

In these exceptional cases the author has succeeded in establishing the following laws:—(1) In no case, in the vascular bundles of the stems of Phanerogams, is a vessel which is still functional bounded immediately by an intercellular space. (2) In the leaves of Phanerogams a tracheid or vessel is never directly bounded by an intercellular space. (3) Throughout the plant the functional vessels and tracheids are always separated from the intercellular spaces by at least a single layer of living cells.

Peculiarities in the Power of Living Parts of Plants to conduct Electricity.†—Investigations of this subject conducted in Sachs's botanical laboratory in Würzburg, have led Dr. Künkel to conclusions which may be briefly summed up as follows:—Parts of plants, the elongation of which is mainly in one direction, exhibit differences in the power of conducting electricity according as the direction of growth is ascending or descending.

Influence of Electricity on Vegetation.‡—A series of experiments carried on by M. Naudin appears to lead to an almost opposite conclusion from the results previously transmitted to the Paris Academy by MM. Grandeau and Leclerc, that the flowering and fructification of plants are retarded and impoverished when they are excluded from the influence of atmospheric electricity.

The earlier experiments were made on tobacco and maize at Nancy and Mettray; and later ones on the tomato and other plants in the warmer climate of Antibes. In both sets isolation was effected by enclosing the plants in an iron cage, covered with a small-meshed iron netting. For the first fortnight of M. Naudin's experiments, there was no apparent difference between the plants in the cage and others grown under precisely similar conditions outside it; but after this time the plants in the cage were decidedly stronger than those in the open air, and this difference became more pronounced as time went on. The periods of flowering, and of the formation and maturing of the fruit, were contemporaneous; but as regards the quantity of vegetable matter produced in a given time and on the same extent of soil, there was a great difference in favour of the caged plants. M. Grandeau believed that trees exert an injurious influence on plants in their neighbourhood by withdrawing atmospheric electricity from them; but this again was not confirmed by M. Naudin's results. He attri-

* 'Oesterr. Bot. Zeitschr.,' xxix. (1879) p. 137.
† 'Arb. Bot. Inst. Würzburg,' ii. (1879) p. 333.
‡ 'Comptes Rendus,' lxxxix. (1879) p. 535.

butes this phenomenon rather to the shade cast by trees, and especially to the exhaustion and desiccation of the soil by their roots, which often extend to a great distance. On the other hand there are many plants which seek the neighbourhood of trees, and which even thrive only under their shadow; and these, probably, must be adapted to a diminution of atmospheric electricity. M. Naudin states that, in some cases at least, the same species is not only more vigorous, but flowers earlier, with larger flowers, under the shade of trees than in more open situations.

His general conclusion is that the influence of atmospheric electricity on plants is complex, varying with the species, and being also modified by climate, season, temperature, degree of light and moisture, and perhaps also by the geological structure or mineralogical composition of the soil.

Absorption of Rain and Dew by the Green Parts of Plants.*—The ancient view of Hales and Bonnet that plants have the power of absorbing rain and dew, was combated by De Candolle, Meyen, Treviranus, and especially by Duchartre, whose conclusions to the contrary effect have been accepted since his time by nearly all vegetable physiologists. The subject has been recently reinvestigated by the Rev. G. Henslow, whose experiments appear to have established conclusively that the older view is the correct one. Not only has this conclusion been confirmed by an independent series of researches carried on by M. Bousingault,† but it is in harmony with the practical experience of all horticulturists.

Without entering into the details of his experiments, which will be found recorded in the paper itself, it may be stated in general terms that the results arrived at by Mr. Henslow are, that dew is not absorbed by saturated tissues at night; but that absorption does take place at and after sunrise, when transpiration recommences, and an indraught is caused by the moisture retained on the leaves; further, that when leaves are purposely or naturally killed by excessive drought, they then do absorb water; as may be proved by the balance, and in other ways.

Decrease of the Power of Absorption in Branches dipped in Water.‡—From a fresh series of investigations on this subject, Dr. F. von Höhnel has come to the conclusion that experiments on the rate of absorption of fluid by cut branches have little value in determining the phenomena which take place in the living plant, an important factor in the former being that the decrease of absorption which takes place after a time is largely due to the formation of mucilage and the appearance of bacteria, causing a partial or entire closing of the vessels.

Water-pores.§—Under this term Langer describes those orifices in the epidermis of the leaves and other green parts of plants which serve

* 'Journ. Linn. Soc. (Bot.),' xvii. (1879) p. 313.
† 'Ann. Chim. et Phys.,' May 1878.
‡ 'Bot. Zeit.,' xxxvii. (1879) pp. 297, 313.
§ 'Oesterr. Bot. Zeitschr.,' xxix. (1879) pp. 79, 105.

for the elimination of drops of water. He has studied their structure and function in detail, following the observations of Borodin, de Bary, and others.

Water-pores are not always to be distinguished by their appearance from ordinary stomata, but may frequently be known by being larger and remaining open when the normal stomata are closed. They have been long known to exist in many plants, as, for instance, many species of fern, water-plants like *Callitriche verna* and *autumnalis*, *Hippuris vulgaris*, and *Ranunculus aquatilis*, and succulent plants like *Colocasia*, *Crassula*, &c. By some authors they have been treated as organs of secretion. They are either solitary or arranged in groups, and are most common on the upper side of the leaf. In *Crassula lactea* small depressions are visible to the naked eye near the margin of the leaf, which the Microscope reveals to be groups of from twenty-five to thirty of these water-pores, covered by a very thin transparent parenchyma. They are distinguished from the ordinary stomata by being rounder, with a nearly circular opening, and by the guard-cells being destitute of chlorophyll. An actual excretion of water was not observed in these—as was the case also in many other instances—and is probably only a temporary function of them. Very similar structures occur in several species of *Crassula*, and others belonging to the same natural order. The leaves of *Primula Sinensis* exude a large amount of water, which the author believes to escape through two large water-pores which he found on the lower side of each tooth. The excreted water yielded carbonate of lime on evaporation. *Colocasia antiquorum* has long been known for the remarkably copious exudation of water from its leaves. Langer found on the upper side of the leaf, near the apex, three gigantic water-pores, through which the elimination appears to take place, with wide-open crevices. The remainder of the stomata on the upper side of the leaf were much smaller, but also wide open. Similar pores were observed on the leaf-stalk, where also an exudation of water takes place. After being placed for fifteen hours in the dark the large water-pores still remained wide open, while the smaller stomata were more or less completely closed.

The observation of these and many other examples led the author to the conclusion that the two functions of the diffusion of gases and the elimination of water are not sharply differentiated in the stomata, but that an ordinary stoma may, at certain times and under certain conditions, become converted into a water-pore, its guard-cells losing their contractile property, and the fissure usually becoming more circular.

Respiration of Plants.*—M. H. Moissan has undertaken a careful series of experiments for the purpose of determining afresh the relation between the volume of oxygen absorbed by plants and that of carbonic acid emitted in respiration. The observations were made by means of carefully constructed apparatus, on a considerable number of trees, shrubs, and herbaceous plants, and with the following results:—

Every living organ absorbs oxygen from the air, and disengages

* 'Ann. Sci. Nat. (Bot.),' vii. (1879) p. 292.

carbonic acid gas. The amount of carbonic acid emitted in respiration has no direct connection with that of the oxygen absorbed. In general, at low temperatures, the quantity of oxygen absorbed is greater than that of carbonic acid evolved. There is a certain temperature, different in different species, in which the two amounts are nearly equal; above this temperature, the production of carbonic acid is in excess of the absorption of oxygen.

Respiration of Marsh and Water Plants.* — Recent investigations by E. Freyberg have been specially directed to the two facts, that the roots of marsh plants can grow and even flourish in media containing very little oxygen, or even none at all, and that marsh plants are, with very few exceptions, useless to mankind. A series of experiments brought out the fact that marsh plants (rice, *Mentha aquatica*, *Caltha palustris*, &c.) show a much smaller power of respiration than land plants belonging to the same natural order (wheat, *Lamium album*, *Ranunculus bulbosus*, &c.), and consequently require much less oxygen. This low power of respiration appears to be accompanied by a small proportion of nitrogen in their chemical composition; a connection depending on well-known physiological facts, the seat of respiration being the protoplasm or albuminoid contents of the cells. In the case of the only two marsh plants which are extensively grown as food-material, rice and the sugar-cane, their value depends not on any nitrogenous constituents, but on the presence of a large amount of a carbo-hydrate.

Influence of Light, Warmth, and Moisture on the Opening and Closing of the Anthers of Bulbocodium vernum.—Kerner has already observed that the anthers of this plant, belonging to the Colchicaceæ, open in the morning and close in the evening. Mikosch has investigated† the cause of this phenomenon, and attributes it to the action of a special layer which forms the innermost portion of the wall of the anther, and which exists only in anthers possessing the property of similar movements. This layer consists of three or four rows of cells, compressed from below inwards, the walls of which always remain thin.

Chemical Researches on the Formation of Coal.‡—M. Frémy finds, as a result of some laborious and complicated experiments, that the plants which have produced coal have done so by undergoing a process of fermentation, which, in converting them into peat, has completely destroyed every trace of vegetable structure, and it is only when the peat has been subjected to the influences of heat and pressure that it has been converted into coal. Coal is not, therefore, an organized structure, as has been supposed.

With regard to the impress of plant-life which is so frequently to be observed in pieces of coal, M. Frémy suggests that it may be very fairly considered that these marks were made when the

* 'Landwirthschaftliche Versuchs-stationen,' xxiii. p. 463; see 'Naturforscher,' xii. (1879) p. 257.
† 'Oesterr. Bot. Zeitschr.,' June 1878.
‡ 'Comptes Rendus,' lxxxviii. (1879) p. 1048.

coal was still plastic. His experiments showing that the principal constituents of vegetable bodies become, when exposed to heat and pressure, converted into substances very like coal, are exceedingly interesting.

New Carbo-hydrate.*—Prof. Schmiedeberg describes a new carbohydrate of the formula $C_6H_{10}O_5$, discovered in the bulbs of *Urginea Scilla*, and hitherto described as a gum, for which he proposes the name *sinistrin*. When pure it is colourless, a white powder when dry, absorbing water readily from the air, and then becoming transparent and gum-like. It is soluble in water, insoluble in absolute alcohol, is not coloured by iodine, does not reduce oxide of copper. Sinistrin is precipitated from its aqueous solution by acetate of lead when there is great excess of ammonia, but not otherwise; when decomposed with lime-water, a slightly soluble amorphous lime-compound is produced. Sinistrin rotates the pole of polarized light to the left; the concentration and temperature of the solution have no influence on the amount of rotation. Saliva and yeast do not saccharify it; but when a dilute solution is warmed with from one to four per cent. of sulphuric acid, it passes over altogether into sugar. This sinistrin-sugar probably consists of levulose and an optically inactive sugar, apparently in the proportion of 5 to 1. Sinistrin is contained in such quantities in the bulbs, along with sugar, that it constitutes the greater part of their dried substance. The author considers it probable that sinistrin is formed from the direct products of assimilation. The pure cellulose of the bulb, when decomposed by dilute acids, yields no trace of levulose, but only sugars with rotation to the right.

Calcium phosphate in the Living Cells of Plants.†—In examining the leaves of *Soja hispida* and *Robinia pseudacacia*, MM. Nobbe, Hänlein, and Councler found, especially in the first-named species, in the parenchymatous cells of the mesophyll, a quantity of peculiar, colourless, moderately refractive bodies, of a roundish, elliptical, or ovoid form, their average size about that of the cell-nucleus, one, or rarely two in a cell. A careful investigation of these structures showed that they consisted of calcium ortho-phosphate.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Germination of Fern-spores.‡—Recent observations by Rauwenhoff, of Utrecht, point to a somewhat different interpretation from that at present generally accepted of the first processes in the germination of the spores of ferns and other vascular cryptogams.

The phenomena presented by the germination of a fern-spore are as follows:—A more or less considerable (but often very small) swelling of the exospore takes place from absorption of water. After some time—less or more according to the species—the wall of the

* 'Zeitschr. Physiol. Chemie,' 1879, p. 112; see 'Bot. Zeit.,' xxxvii. (1879) p. 513.

† 'Landwirthschaftliche Versuchs-stationen,' xxiii. p. 471; see 'Naturforscher,' xii. (1879) p. 276.

‡ 'Bot. Zeit.,' xxxvii. (1879) p. 441.

spore opens at the point of junction of the three ridges in radiate, or in the middle of the single ridge in bilateral spores. Through this opening protrudes a papilla, which develops protoplasm and chlorophyll like a young cell, and, either at once or after a short time, puts out a second papilla, the first rhizoid; both cells subsequently developing in various ways. The usual explanation of these appearances is that when the exospore bursts, the endospore develops and forms the wall of the first cell of the prothallium, as also usually of the first rhizoid; the contents of the spore passing over into these two cells.

In following out this process, Rauwenhoff met with the difficulty that, although chemical tests failed to detect the presence of cellulose in either the endospore or exospore before germination, this substance is clearly present in the papilla and in the parietal portion of its contents in the earliest stages of germination. He gives a detailed description of the phenomena observed in the germination of the spores of *Gleichenia*, which are especially favourable for observation, owing to the transparency of the cell-wall of the spore, and comes to the conclusion that the source of the wall of the first prothallium-cell and of the first rhizoid is not the endospore or inner shell of the original wall of the spore, but a new cellulose wall secreted out of the protoplasm of the spore before it opens, and increasing in the ordinary way by intussusception.

The source of the ordinary interpretation of the first stage in germination is doubtless a false analogy with the process of development of the pollen-tube, which undoubtedly results from the growth of the intine or inner coating of the wall of the pollen-grain.

That the germination of the spores of other vascular cryptogams will be found to agree with that of *Gleichenia* rather than with the development of the pollen-tube of phanerogams, where observation of these processes is possible, is concluded by Rauwenhoff from the following considerations. A section of pollen-grains in which the pollen-tube has begun to develop, shows that where the tube has broken through, the wall consists of fewer layers than elsewhere, that is, of the extine only. In fern-spores, on the contrary, the wall is of the same thickness, and consists of as many layers after germination as before; showing that the protruding wall of the papilla must be a new membrane. The changes in the contents of the spore on germination are also much more extensive than those of the papilla of the pollen-grain when the tube is formed. The intine of pollen-grains consists, moreover, of cellulose, which is certainly not generally the case with the endospore of such fern-spores as have been carefully examined. This explanation also corresponds with what is known to take place in the formation of the zygospore of *Spirogyra* and other Conjugatæ, as well as with the processes observed in the germination of the spores of Equisetaceæ, Hepaticæ, and Bryineæ.

Bilateralness of Prothallia.*—In opposition to the opinion of Bauke,† Leitgeb still maintains his view that the bilateralness of the

* 'Flora,' lxii. (1879) p. 317. † See this Journal, *ante*, p. 451.

prothallium of ferns (i.e. the exclusive tendency of one side to produce antheridia and archegonia) is the result mainly of a difference in the supply of light, rather than of gravitation; the organs of reproduction being produced only on the shaded side. His conclusions were confirmed by the following observations on *Ceratopteris thalictroides*.

Prothallia of this fern are produced with ease by sowing the spores on a nutrient fluid. When lighted from above, the prothallia expand on the surface of the water, or raise themselves above it, turning one side to face the light. Only the shady side produces archegonia, the rhizoids springing either from it or from the marginal cells, and growing downwards into the fluid. But when the light reaches the prothallia from below, the result is quite different. They grow down into the fluid to meet the light, but curve, as soon as the true surface begins to develop, so that one surface is placed at right angles to the incident light. The conditions with respect to contact with the substratum are therefore here the same on both sides, and yet the archegonia, as well as those rhizoids which spring from the surface, are produced on one side only, viz. the shady side. The rhizoids also do not grow downwards, but spread themselves over the surface of the fluid; they are therefore not positively geotropic, but to a certain extent negatively heliotropic.

These prothallia are also instructive in another respect. The rhizoids are, as is well known, produced especially at the basal end of the cells. This occurs also in the parts of the prothallium which grow obliquely downwards, proving that it is not gravitation that determines their place of origin, but that it depends on the contrast of base and apex of the prothallium.

Development of the Prothallium of Salvinia.* — Prantl has closely followed out the history of development of the prothallium and reproductive organs of *Salvinia natans*, with the following results, which are not in every respect in harmony with those previously arrived at by Bauke.† In addition to the wall of the sporangium, the true spore is surrounded by a small-celled integument, the exospore of Pringsheim, but more correctly called the epispore by Russow and Sachs. This is firmly attached to the thick yellow exospore, which, on germination, becomes detached in three lobes from the apex of the spore. At the same time the epispore is also burst into three lobes. The ripe spore always swims on the surface of the water, and is not merely buoyed up by algæ, as Hofmeister supposed; the entire epispore serving as a swimming apparatus. Germination takes place, under favourable conditions, about Christmas.

The germination, development of the prothallium, fertilization, and the development of the young plant until the "peltate leaf" has attained its full size, take place in the dark, but with formation of chlorophyll. The first cell-formations in the prothallium are exceedingly difficult to follow. The meniscus-shaped anterior portion of the spore is first of all separated from the large spore cavity by a single basal wall, the "hyaline membrane" of Pringsheim. A young

* 'Bot. Zeit.,' xxxvii. (1879) p. 425. † This Journal, *ante*, p. 753.

prothallium seen from above, i. e. from the apex of the spore, has a nearly equilateral triangular form with rounded angles alternating with the lobes of the exospore. The first wall is vertical, cutting off one of these angles. This portion, which may be called the sterile third, develops into the large-celled knob which is always found at the base of the archegonial surface of the prothallium, and never bears archegonia. The further cell-division and formation of the archegonia is described in detail in the paper. In the majority of cases the archegonia are formed only on the ventral surface of the prothallium which bears the "lump" behind; but sometimes extends somewhat on both sides, and even reaches the dorsal surface. The distinction between the dorsal and ventral surfaces is clearly not due, as in ferns, to a difference in the illumination, but is inherent in the prothallium.

The original tripolar development of the prothallium appears to present some analogy with that of Hymenophyllaceæ, except that the large spore-cavity is first of all divided off by a septum. The mode of formation of the archegonia reminds one again of *Selaginella*, in which the archegonia form three rows alternating with the lobes of the exospore. In *Salvinia* there are only two rows; the third side remaining sterile, and forming the "lump."

Muscineæ.

New Bryum.*—Mr. H. Boswell describes a *Bryum* gathered in Teesdale, without flowers or fruit, the form and texture of the leaves, however, appearing distinct and sufficient to render it well marked.

The name—*B. Origanum*—was suggested by the peculiar odour, and it is thus characterized:—

"Stems elongated, about an inch or more, copiously radiculose and forming dense soft tufts. Leaves ovate and ovato-lanceolate, shortly pointed, scarcely acuminate, concave, nerved almost to the apex, cells leptodermous, oblong and nearly rectangular, margins plane, slightly recurved when dry, formed of a single row of narrower cells."—Shady old wall, Teesdale.

In soft dense tufts, foliage full green, the young leaves at the summit rosy-pink, the old foliage of former years and lower part deep brown, stems and leaves matted with numerous radicles. Habit and general aspect much as in *B. barbatum* Wils., or some forms of *B. æneum* from Norway—from the former it differs in the form of the leaves, which are not piliferous-acuminate, in the nerve ceasing below the apex, in the form of the cells, and their very thin walls.

Fungi.

Structure of Chætomium.†—W. Zopf has investigated the structure and development of this genus of Sphæriaceæ,‡ and contributes the results to the 'Proceedings' of the Botanical Society of Brandenburg. He regards all the species which have hitherto been described as modifications of a single one—which he calls *Chætomium bostrychodes*,

* 'Naturalist,' v. (1879) p. 33.
† See 'Hedwigia,' xviii. (1879) p. 91.
‡ Placed, in Cooke's 'Handbook of British Fungi,' among the Perisporiacei.

distinguished by an ellipsoidal perithecium, minute spores, about 6 μ in diameter, and a tuft of elegant hairs.

Proposed New Genus of Fungi—Peniophora.*—Dr. Cooke proposes to separate sixteen species of the two Friesian genera of *Corticium* and *Stereum* (of the order Auricularini of Hymenomycetous Fungi), and to unite them in a new genus under the name of *Peniophora* (πηνίον, a shuttle). He points out that Fries paid little or no attention to microscopic characters, so that his whole classification of the Hymenomycetes was limited to what could be detected by a common lens. In these days of microscopic research such a limit is scarcely satisfactory, and in the above two genera there are structural features which indicate that Fries' arrangement was not so perfect as it might have been had he brought the Microscope to his aid.

The new genus includes those species in which the hymenium is beset with short, rigid, uncoloured, rough, projecting cells ("metuloids") which are attenuated upwards or subfusiform and give the surface a velvety appearance, the old genera retaining only the species in which these shuttle-shaped bodies are absent, the hymenium being naked.

Vine Fungi.†—The various fungi which attack the vine, either as parasites or as saprophytes, have been carefully studied, enumerated, and described by von Thümen, and classified according to the part of the plant on which they are found. On the grapes he describes only a single species, *Macrosporium uvarum* (new); on the woody parts no fewer than twenty-four species, a large number of them new, belonging to the genera *Fusarium*, *Diplodia*, *Leptothyrium*, and others. Parasitic on the leaves are six species, all described as new; while on the root is a single species, *Rœsleria hypogæa*, new not only specifically, but also generically, belonging to the Helvellaceæ.

Propagation of Cluster-cups.‡—Dr. Cooke, in his 'Introduction to the Study of Microscopic Fungi,' calls attention to the difficulty of accounting for the appearance of the cluster-cups (*Æcidiacei*) bursting through the cuticle of the leaves of the plants on which they are found. The question is as to the manner in which their spores reach the interior of the leaf where they germinate. It certainly cannot be by way of the stomata, for these are too small, nor would this account for the preservation of the spores until the succeeding year. Equally difficult is it to imagine a process by which they can gain access to the interior of the growing leaf through the roots, nor have they been traced passing through the tissues of the plants. Dr. Cooke mentions the fact, however, that the Rev. M. J. Berkeley was able to propagate cluster-cups by growing plants from seeds which had been placed in contact with their spores.

Following this hint, and noting the fact that certain species ripen and discharge their spores at the time when the plants on

* 'Grevillea,' viii. (1879) p. 17.
† F. von Thümen, 'Die Pilze des Weinstockes,' Vienna, 1878; see 'Hedwigia,' xvii. (1879), p. 118.
‡ 'Am. Naturalist,' xiii. (1879) p. 467

which they are found are in blossom, Mr. M. A. Veeder, of New York, anticipated that these spores would be found along with the pollen in the interior of the ovary, thus coming into contact with the seeds and depositing the germs of future growth. Acting upon this hypothesis, he examined the flowers of *Podophyllum peltatum* and *Arisæma triphyllum* growing within a few feet of plants of the same species whose leaves were covered with cluster-cups, and in many instances found the orange-coloured spores among the pollen in the ovary. He also found pollen from *Podophyllum peltatum* mingled with the spores dusted over the leaves of a plant of the same species at a distance of several feet from any blossom, indicating, apparently, that it had been transported by insects.

Onion-smut, Urocystis Cepulæ.*—A parasitic fungus, excessively destructive to the onion, was first observed in North America, in the States of Connecticut and Massachusetts, about twelve years since, and was first described by Dr. Farlow † under the name of *Urocystis Cepulæ.* Although committing great ravages on the crops in those States, it was very local, being unknown in that of New York. Hitherto the fungus has been supposed to be confined to the New World; but M. Cornu has now detected it in the neighbourhood of Paris, on an early variety of the white onion known as the "*Oignon de Nancy.*" It attacks the bulb-scales and the bases of the leaves, reducing them to a black powder. Dr. Farlow considers that the fungus has invaded the onion from some wild species, and Dr. Cooke considers it a variety of *Urocystis Colchici*, a parasite of the autumn crocus.

Lagenidium Rabenhorstii, a new Phycomycete.‡ — W. Zopf reports the discovery of this new parasitic fungus, which was causing great ravages among the *Spirogyra* and other Conjugatæ in the water in the Zoological Garden in Berlin, to the Proceedings of the Botanical Society of Brandenburg. The reniform biciliated zoospores attached themselves to the host, penetrating the cell-wall by means of a perforating tube, and developing in the interior into a mycelium, which, in its non-reproductive condition, is unicellular, of small dimensions, and unbranched. The zoosporangia become subsequently separated by a septum. Sexual plants spring from two zoospores which penetrate into the same cell of the host; the antheridia and oogonia resembling those of the class generally. Though coming nearest to *Lagenidium* of any known genus, it differs from the species hitherto known in the form of the zoospores and the number of the cilia.

The author divides the family of Saprolegniaceæ into two groups:—(1) the typical Saprolegnieæ, in which there is a distinct differentiation of a vegetative and a reproductive portion, including the genera *Saprolegnia*, *Pythium*, *Cystosiphon*, &c.; and (2) the Ancylisteæ of Pfitzer, in which no such differentiation is evident, and in which must be included the genera *Ancylistes*, *Myzocytium*, *Lagenidium*, and *Achlyogeton.*

* 'Comptes Rendus,' lxxxix. (1879) p. 51.

† Twenty-fourth Ann. Rep. of the Sec. of the Massachusetts State Board of Agriculture, Onion-smut, 1877.

‡ See 'Hedwigia,' xviii. (1879) p. 94.

Protomyces graminicola.*—Dr. Schrœter has detected this fungus, recently described by Saccardo, in great quantities on *Setaria viridis* and *S. glauca*, and finds it identical with *Ustilago Urbani* Magnus. He considers it an endophytic Phycomycete, belonging either to the family Peronosporeæ or Pythiaceæ.

The fungus was especially abundant on the above-named grasses where they constituted the most abundant weeds in potato-fields; and in this situation Schrœter found on *Setaria* a conidia-bearing fungus, the identity of which with the one in question he could not doubt. This corresponded very closely with the smaller species of *Peronospora*, such as *P. pygmæa*, but was distinguished by the acute ends of the branches. He considers the fungus to be therefore a true *Peronospora*, but belonging to a new section, which he calls *Sclerospora*, distinguished by the unequally thick dark-brown envelope consisting of several layers, formed out of the oogonium wall, and the dusty spores. With the exception of *P. Schleideniana* on *Allium Cepa*, this is the only *Peronospora* hitherto detected parasitic on a monocotyledon. Schrœter thinks that the parasite may be of economical value from its destructive influence on very widely distributed agricultural weeds.

Conidial Fructification in Mucorini.†—Dr. Cunningham describes the complete life-history of *Choanephora*, a mucedinous fungus, parasitic on the corolla of *Hibiscus* and other shrubs in India, including no less than four distinct forms of fructification. Of the reproductive bodies one kind, the zygospores, are sexual, and the other three non-sexual:—conidia, sporangial spores, and chlamydospores. The sporangial and chlamydosporic reproductive bodies appear to be more closely allied to one another than to the conidia. They are new and independent cells formed within the tubular system of the parent plant; but the conidia are merely isolated portions of that system, being, in fact, only the tips of the terminal filaments of the aerial portion of the plant. The distinction is not merely an anatomical one; the fact that the difference in the nature of the conditions favours the development of the various forms of fructification, indicates a physiological distinction also. The conidial fructification is the form characteristic of active nutrition and vegetative growth. Given a very rich nutritive medium and fully developed normal conidia, a luxuriant development of mycelium occurs, followed, sooner or later, by an abundance of conidial fructification. With diminishing nutrition there is progressively poorer mycelial development and less-developed conidial fructification. When this degeneration has reached its utmost limit, when the conidial fructification is reduced to its poorest and simplest type, the sporangia begin to make their appearance; and when the conditions of nutrition are too greatly lowered even to allow of this, we find the chlamydosporic fructification providing for the preservation and diffusion of the plan.

Dr. Cunningham's observations are in one point inconsistent with those of Van Tieghem and Le Monnier, who deny that true conidial fructification ever occurs in the Mucorini; and the conjunction of these various forms in one species would destroy Brefeld's proposed

* 'Hedwigia,' xviii. (1879) p. 83.
† 'Trans. Linn. Soc. (Bot.),' i. (1879) p. 409.

classification of the Mucorini or Zygomycetes into two sub-families, one distinguished by sporangial, the other by conidial non-sexual fructification.

Beech Disease, Phytophthora Fagi.*—Professor Hartig finds that this disease of young beech-seedlings is spread by the oospores which germinate in the soil. The mycelium differs from that of other Peronosporeæ in being septated. The mode of formation of the sporangia is similar to that described by de Bary in the case of *Phytophthora infestans*. The germinating filaments of the zoospores creep along the surface of the leaf, and penetrate between the epidermal cells, sporangia being produced in the course of two or three days. The mycelium and sporangia develop chiefly in the cotyledons, much less luxuriantly in the foliage-leaves.

The formation of oospores takes places as follows:—On the intercellular mycelial filaments are formed numerous not very long lateral hyphæ, which swell up into a club-shaped form, producing oogonia at the extremity. The oogonium is thin-walled, filled with protoplasm, and is divided off from the hypha by a partition wall, being thus elevated on a short stalk. In the neighbourhood of each oogonium is produced at the same time a much smaller antheridium by the swelling into a club-shaped form of the apex of a hyphal branch, which usually becomes attached to the oogonium near its base. The wall of the oogonium not unfrequently exhibits an indentation at this spot; but the coalescence of the two sexual cells consists simply in a union of growth, and the resorption of the substance of the wall of the oogonium at a small round spot; there is no forcing itself of the antheridium into the oogonium by means of a beak-like process. The contents of the antheridium, which is divided off from the hypha by a septum, then pass over into the oogonium; the protoplasm of the oogonium somewhat contracts, and an oospore is produced, at first with a thin, afterwards with a very thick wall. The oospores may either germinate directly, or they may retain their power for at least three years.

The disease has at present nearly confined its attacks to nurseries, where the young plants are very crowded. The practical remedy appears to be to refrain from planting the seed in soil likely to be infected with the oospores.

Berggrenia—New Genus of Discomycetes.†—Dr. Cooke describes an aberrant genus of the Discomycetes which possesses a general interest to the mycologist as a new arrangement or inversion of organs. The fungus was collected in 1874–75, by Berggren, of Lund, during his visit to New Zealand, and the name *Berggrenia* is proposed for it. It is ovate, pyriform, somewhat clavate, about one inch in height, and nearly as much in breadth, but compressed laterally to one-fourth of that thickness in one direction. It looks very much like a *Tremella*, being a little plicate or rubbed below and inflated, so that the centre is hollow, and though attenuated a little at the base

* 'Forstwissenschaftliches Centralblatt,' i. (1879); see 'Bot. Zeit.,' xxxvii. (1879) p. 511.

† A paper read by Dr. M. C. Cooke at the annual meeting of the Woolhope Club, at Hereford, October 2, 1879; see 'Gardeners' Chronicle,' 1879 (Oct. 25) p. 533.

there is no distinct stem. The base is watery white, the upper half a bright reddish orange.

For some time Dr. Cooke was puzzled with this, which at first he regarded as a *Tremella*, or *Guepinia*, or it might be an ally of *Spathularia;* softened and examined under the Microscope no external trace of hymenium could be found, nothing but a tough cellular tissue of large and uniform cells, until cutting open one of the specimens, he found the inner walls softer, rugose, and so different in texture that at once, more out of curiosity as to the character of the cells, than hope to find the hymenium, he examined a portion of the inner wall, and found it to consist entirely of an effused hymenium of large, closely packed, cylindrical asci, each containing its eight elliptical sporidia, but without paraphyses. In fact there is here an inflated fleshy sac, with the hymenium enclosed and covering the whole of the inner surface. It is a *Spathularia* turned inside out, and is of far more importance than a mere new species or genus could be, presenting a most interesting subject for study, and adding yet another to the contrarieties of the antipodes.

With respect to the affinities of the new fungus, there is no doubt whatever that the hymenium is entirely enclosed, normally. Perhaps *Sphærosoma* comes nearest to it, except that it has a thicker and firmer periderm, and is moreover hypogæous. This affinity is sufficient to prove that it is not impossible for a plant of such a structure to be a Discomycete, and Tulasne considered *Sphærosoma* to be a Discomycete although evidently so very closely related to *Genea*. Indeed, in Dr. Cooke's opinion *Sphærosoma* is further removed from the Discomycetes in the direction of the Tuberacei than *Berggrenia* from some species of *Peziza*.

There is a great similarity in the character of the fruit, and in the fleshy stroma, as to texture, &c., between *Cyttaria* and *Berggrenia;* in fact, the latter resembles the former, inverted, and the areolæ suppressed. The hymenium is confined in some *Cyttariæ* to a few nearly closed cells, and although the relationship is by no means close in any direction, *Berggrenia* should be placed, it is suggested, in the Bulgariacei, nearest perhaps to *Cyttaria*. The discovery hereafter of intermediate links may render the affinities clearer than at present they seem to be.

Microphytes in the Blood and their relation to Disease.* — Mr. T. R. Lewis contributes a paper of fifty pages on this important subject, giving a critical *résumé* of the work of former observers, as well as the results of his own investigations.

Mr. Lewis, first of all, goes over the evidence for the opinion that bacteria are the actual cause of the morbid symptoms in splenic fever, septicæmia, infectious pneumo-enteritis of the pig, and recurrent fever, the diseases in which there is the strongest evidence for a *contagium vivum*. He then recounts some observations of his own as to the occurrence of bacteria in the blood of perfectly healthy animals, and gives his reasons for thinking that the presence of microphytes in the blood is a mere epi-phenomenon, having no

* 'Quart. Journ. Micr. Sci.,' xix. (1879) p. 356.

causal relation with the disease. The chief reasons adduced may be summed up as follows:—

1. It is by no means proved that the various forms of *Bacillus*, *Spirillum*, &c., occurring in certain diseases are specifically distinct from forms having no relation whatever to any pathological conditions.

2. All the representatives of the Schizomycetes may be and have been introduced into the blood without causing any morbid symptoms.*

3. In the diseases supposed to be due to bacteria, the microphytes are "never to be detected in the earlier stages of the disease, but only at a brief period before and after a fatal termination."

4. "The poisonous properties of septinous blood and of other decomposing animal solutions gradually disappear toward the third or fourth day, a fact which is scarcely reconcilable with the doctrine that the poison resides in the almost imperishable 'spores' of the bacilli, which existed during the earlier stages of decomposition."

5. Septinous fluids retain their virulent properties after filtration through fine porous materials, the effect of the filtration being to free them from "visible molecules of every description."

6. "The coagulum produced by boiling a septinous fluid is more virulent than the fluid itself." Eleven hours' boiling does not destroy the poisonous properties of such a fluid; a watery extract of the residue of such a fluid evaporated to dryness has an intense toxic effect.

7. The poison (septine or sepsin) of some of these fluids may be made to combine with acids so as to form salts, which latter retain all the toxic properties of the original fluid.†

8. The living tissues, under the influence of a chemical irritant (iodine or ammonia), may secrete a virulent fluid, capable of communicating disease from animal to animal.

Mr. Lewis concludes "that the living tissue elements of the body itself play a much more important part in the elaboration of septinous and allied poisons, than what has of late been ordinarily ascribed to them."

Crenothrix polyspora, the Cause of the Unwholesomeness of the Berlin Water.‡—According to Dr. Zopf, this is a nostoc-like fungus, which has developed, from some unknown cause, in enormous quantities in the wells of Berlin. The filaments are enclosed in a gelatinous envelope; but the cells readily become isolated, and develop into new filaments. There are also very minute gonidia produced by division of the cells of a filament; these are also enclosed in gelatinous envelopes and develop into filaments, and, under certain circumstances, into palmella-like colonies of cells. From the absence of chlorophyll, *Crenothrix* appears to occupy an intermediate position

* With regard to these two points, cf. Koch, 'Wundinfectionskrankheiten,' *ante*, p. 754.

† The possibility that the non-living contagium indicated in §§ 5, 6, and 7 may itself be a result of organic action, should not be lost sight of.

‡ 'Entwickelungsgeschichtliche Untersuchung über *Crenothrix polyspora*,' von Dr. W. Zopf, Berlin, 1879; see 'Bot. Zeit.,' xxxvii. (1879) p. 546.

between the Oscillarieæ and the Bacteria. Rabenhorst's name, *Crenothrix Kühniana*, would, however, appear to be justified by the laws of priority. Largely distributed through the water of wells and waterworks, it occurs also in the soil. Both the filaments and the palmella-colonies are coloured ochre-yellow or brown by deposition of iron.

Fungi Parasitic on Fungi.*—A careful examination of a very large number of examples has convinced S. Schulzer that in many cases where forms of fungi have hitherto been believed to be different stages in the same cycle of development, they are really distinct species, the one parasitic on the other; and that very great care is required to determine which of these two is the case.

In some cases the parasite appears to exercise no injurious influence on the host; but far more frequently it in time partially or completely destroys it, and then presents very much the appearance of springing from it as a succeeding stage of development. In the case of the larger Hymenomycetes, the parasite often prevents the formation of the spores, its own conidia then appearing to take their place. Thus *Artotrogus Ditmarii* causes sterility in the lamellæ of *Nyctalis asterophora; Lactarius deliciosus* shows no indication of the formation of lamellæ when attacked by *Hypomyces lateritius;* and *Agaricus cæsareus* is similarly affected by *Mycogone rosea.*

Poison of Marsh Fever.†—The physical cause or poison to which marsh or intermittent fever is due, was made the subject of special investigation during the spring of the present year by Signor Tommasi, professor of pathological anatomy at Rome, in conjunction with Professor Klebs, of Prague. According to an account laid by the former before the Academy of Rome,‡ the investigation was rewarded with complete success.

The two investigators spent several weeks during the spring season in the *Agro Romano*, which is notorious for the prevalence of this particular kind of fever. They examined minutely the lower strata of the atmosphere of the district in question, as well as its soil and stagnant waters; and in the two former they discovered a microscopic fungus, consisting of numerous movable shining spores of a longish oval shape, and ·9 micromill. in diameter. This fungus was artificially generated in various kinds of soil; the fluid matter thus obtained was filtrated and repeatedly washed, and the residuum left after filtration was introduced under the skin of healthy dogs. The same thing was done with the firm microscopical particles obtained by washing large quantities of the surface soil. The animals experimented upon all had the fever with the regular typical course, showing free intervals, lasting various lengths of time up to sixty hours, and an increase in the temperature of the blood during the shivering fits up to nearly 42°, the normal temperature in healthy dogs being from 38° to 39° centigrade. The filtrated water only caused changes in the temperature of the body, even when five times the original quantity of water was administered, and the trifling fever

* 'Oesterr. Bot. Zeitschr.,' xxix. (1879) pp. 112, 155.
† 'Times,' 1879, October 8.
‡ 'Transunt. Acad. Lincei,' iii. (1879), p. 216.

actually caused was not of an intermittent character. The animals artificially infected with intermittent fever showed precisely the same acute enlargement of the spleen as human patients who have caught the disease in the ordinary way, and in the spleens of these animals a large quantity of the characteristic form of fungus was present. The fungus was also found abundantly in other lymphatic vessels of the animals. As the fungus here grows into the shape of small rods, Tommasi and Klebs gave it the name of *Bacillus malariæ*.

The strictly scientific method pursued in this investigation does not admit of a doubt that the accomplished investigators have really discovered the cause of the disease in question. The discovery may be regarded as another of the series of which those in connection with inflammation of the spleen and diphtheritis were earlier examples. Against the intermittent fever poison, which is connected with this newly-discovered microscopic fungus, the medical art was formerly as powerless as it is still against diphtheritis and inflammations of the spleen. For intermittent fever, however, medicine was provided with a remedy when the virtues of quinine were made known, and it may be reasonably expected that, as in the latter case, so against the poison of the diphtheritic fungus and that of splenetic inflammation, medical science will sooner or later discover their appropriate antidote.

It is announced * that Drs. Marchiafava and Valenti have since detected the *Bacillus* in human patients in a more advanced stage than in the animals originally dissected.

Development of Bacteria.†—The following are the results of a series of experiments undertaken by A. Prazmowski in the botanical laboratory at Leipzig on the development of various bacteria, and especially on their alleged power of producing spores.

1. *Bacillus subtilis*. With regard to this species, the author fully confirms the observations of Brefeld with respect to the production and germination of the spores. But as regards the statement of Cohn and Van Tieghem, that it is the cause of butyric fermentation, he believes he has proved that this is certainly not the case.

2. The butyric ferment, Vibrion butyrique, *Amylobacter*, or *Bacillus Amylobacter*. The young rods are difficult to distinguish from those of *B. subtilis;* but in nutrient solutions they develop into longer and distinctly septated threads. The formation of the zooglœa-form is, however, very different. A single rod is always the origin of a zooglœa-colony; after coming to rest it divides into two derivative rods, which then separate and lie nearly side by side. After this has been repeated several times, a copious development of mucilage takes place. The author contests Van Tieghem's statement that this organism has the power of causing fermentation in cellulose and other carbo-hydrates, maintaining, on the contrary, that the substance produced is always butyric acid, as is proved by the smell as well as by chemical analysis.

3. *Vibrio Rugula*. This bacterium was found in cultures of the butyric ferment.

4. *Bacillus Ulna*. This species is readily distinguished from

* Loc. cit., Nov. 12. † 'Bot. Zeit.,' xxxvii. (1879) p. 409.

other bacteria by its size, and by its peculiar somewhat heavy movement.

In a communication to the French Academy,* Van Tieghem disputes the accuracy of Prazmowski's observations as far as *Bacillus Amylobacter* is concerned, and repeats his previous results. The correctness of his conclusion he considered to be proved by the invariable disengagement of hydrogen.

Experimental Researches on a Leptothrix.†—M. Feltz presented, on the 9th of June, a "rectification" of his earlier communication,‡ in which he details his correspondence on this subject with M. Pasteur, who was of opinion that the so-called new form was the *Bacterium* of anthrax-poisoning, and furnished him with a guinea-pig suffering from the disease, and with another poisoned with his own *Leptothrix*. The result of the examination of their blood was to convince M. Feltz of the correctness of M. Pasteur's view. M. Pasteur adds a short note, in which there is one point of especial importance in these days—"Je me suis abstenu généralement de donner des noms spécifiques à ceux de ces organismes que je pouvais croire nouveaux."

Antidote to Bacteria-poisoning in Frogs.§—Bacteræmia is, in the frog, always accompanied by an alteration in the characters of the blood-corpuscles, and this alteration has a proportional relation to the gravity of the condition of the poisoned frog; a small subcutaneous dose of phenate of soda (e. g. about $\frac{4}{1000}$ milligramme for each gramme of the frog's weight) is found to be an efficient antidote.

Sugar-refining Gum, Leuconostoc mesenteroides.‖—It has long been known to the manufacturers of beet-root sugar that a gelatinous gummy substance, of a firm and elastic consistency, composed of white lumps of moderate regularity intimately associated into a kind of parenchyma, makes its appearance on the sacks in which the cut beet-root is pressed, on the presses themselves, on the sieves through which the juice passes, and less often in the boiled syrup. This substance is known in France as *gomme de sucrerie*, in Germany as *Froschlaich* (frog's spawn). The part of this substance soluble in alcohol contains mannite, fatty acids, glycerophosphoric acid, and a nitrogenous principle, betain or oxynevrin. The insoluble part, much the most considerable, is almost exclusively composed of a substance with the composition $C_{12}H_{10}O_{10}$, endowed with a rotatory power to the right ($a_1 = 223°$), three times that of cane-sugar, and greater than that of dextrin or starch. It has been called by Scheibler *dextrane*. At first supposed to be a non-organized protoplasmic product of the cells of the beet, several observers subsequently determined its organic nature; and it was seen to have considerable affinity with *Nostoc* on the one hand, and with Cohn's genus of bacteria *Ascococcus* on the other hand.

Van Tieghem has recently subjected this organism to a searching

* 'Comptes Rendus,' lxxxix. (1879) p. 5. † Ibid., lxxxviii. (1879) p. 1214.
‡ See *ante*, p. 454. § 'Rev. Internat. Sci.,' iv. (1879) p. 88.
‖ 'Ann. Sci. Nat. (Bot.),' vii. (1879) p. 180.

investigation, derived from experiments both on the beet and on the date and carrot. He considers it to have a close analogy with *Nostoc* in its mode of germination and development, its structure in the adult state, and its reproduction; but, differing in the absence of chlorophyll, he proposes for it the distinctive name of *Leuconostoc*, a new genus of bacteria, most nearly allied to *Ascococcus* and *Myconostoc* of Cohn. It would then occupy a position in the family of Schizophytæ, and in Cohn's tribe of Nematogenæ, in the same section as *Nostoc* and *Hormosiphon*, but constituting by itself the only member of the series destitute of chlorophyll, known as Phycochromaceæ. It develops with extraordinary rapidity in a suitable medium, but has not the character of a ferment. Its effects are extremely injurious to the industry.

Excrescences on the Root of the Alder.*—Tubercular excrescences on the root of the alder have long been a subject of investigation, and have been referred by some to malformation and hypertrophal growth, by others to the prick of an insect; while M. Woronine attributes them to the attacks of a parasitic fungus, to which he gave the name *Schinzia Alni*, and of which he believed he had detected both the mycelium and the spores.

M. Gravis, who has subjected these bodies to fresh examination, has been unable to confirm the observations of Woronine. He considers them to partake rather of the nature of a gall; the substances found in the cells he regards as amylaceous or albuminoid reserve-materials stored up for the purpose of nutrition. Even should the phenomenon be due to the attacks of a parasitic fungus, M. Gravis thinks its systematic position has yet to be determined.

Lichenes.

Vitricole Lichens and the Schwendenerian Hypothesis.†—Dr. Nylander has a note in 'Flora' upon Vitricole Lichens, from which the Rev. J. M. Crombie gives the following extract, which bears directly upon Schwendener's theory.

After observing that he had already ‡ stated that it was useless to study the germination of lichens from spores cultivated at home,§ because in Nature itself not only the earliest stages of germination, but also the whole development of lichens, can readily be perceived on quartzose rocks or smooth bark of trees,‖ Dr. Nylander proceeds to notice that the same may still more easily be observed on glass which has been exposed for a long series of years in districts where lichens are of common occurrence. "There, on the very pure surface of the glass, we have under the Microscope before our eyes, numerous germinations and prothalline formations, and then gradually advancing the beginnings of the primary glomeruli of the thallus (as

* 'Bull. Soc. Roy. Bot. Belg.,' xviii. (1879) p. 50.
† 'Flora,' lxii. (1879) p. 303; see 'Grevillea,' viii. (1879) p. 30.
‡ 'Flora,' 1877, p. 356, and 1878, p. 247.
§ *Vide* also Crombie in 'Pop. Sci. Rev.,' 1874, pp. 267–8.
‖ To this also may be added, on mortar of walls and houses, as in the suburbs of London.

are sufficiently well figured in 'Tul. Mem. Lich.,' t. 3, f. 3), and behold the whole process of evolution from the germinating spore to the perfect thallus, and at length to the formation of the perfect apothecium. All of these are seen to be formed of themselves, that is, by an innate power or impulsion of procreation, which is inherent in the spore, the only aiding materials being those lent by the atmosphere, especially rain-water. Upon the very pure glassy substratum where these vital phenomena go on, no trace of any *Protococcus* (or *Pleurococcus*), nor of any element of a heterogeneous thallus can be detected in the vicinity, although innumerable examples of such germinations have been examined in very favourable circumstances, especially in *Lecanora galactina* Ach., *Lecanora exigua* Ach., and *Lecidea alboatra* Hoffm., growing upon glass. The prothalline commencements of *Lecanora exigua* radiate dendritically around the spores, and are of a blackish colour, forming the hypothallus, in which minute, cellulose, thalline glomeruli are produced, presently exhibiting gonidia forming themselves in the cells (as in Tul. Mem., *l. c.*); often also we see apothecia produced even in a very young plant. The same is the case with the beginnings of *Lecanora galactina*; * but here the hypothallus is white, consisting of white, byssine, appressed filaments, laterally apposite and contiguous. All these hypothalli are very closely agglutinated to the glass; and there are no traces whatever of any *Protococci* in connection with them."

These observations of themselves (Mr. Crombie says) in connection with Vitricole Lichens (which, in this country, he has only observed on broken pieces of bottles on garden-wall tops, chiefly in Scotland) are amply sufficient to show how untenable is Schwendener's hypothesis, which, in the concluding words of Nylander's paper, is thus "reduced to the nothingness from which it ought never to have emerged."

Parasitism of Lichens on Mosses.†—H. Zukal, having observed the frequent occurrence of luxuriant lichen-growths in the midst of tufts of moss, has determined the cause to be a parasitism of the lichen on the moss.

The stem and leaves of *Plagiothecium sylvaticum* were penetrated in all directions by the hyphæ of the thallus of a *Pertusaria* and those of *Hypnum splendens* by a *Lepraria*. The stems of a plant of *Polytrichum commune*, up to the rosette of leaves, were found to be infested with minute patches of the thallus of a *Cladonia*. In one case the lichen had attached itself to the apex of the leaf of the *Polytrichum*, and completely penetrated the leaf with its rhizines. The gonidial layer of the lichen was in these cases normally developed.

Colorific Properties of Lichens.‡—The subject of the colouring matters contained in lichens—to which Dr. Lauder Lindsay directed attention in 1853–5—has recently reacquired, he says, considerable interest in connection with the introduction of colour-tests, as

* This Mr. Crombie says he can entirely corroborate from his own observations on this species, as growing on mortar in the north suburbs of London.

† 'Oesterr. Bot. Zeitschr.,' xxix. (1879) p. 189.

‡ 'Grevillea,' viii. (1879) p. 25.

characters for species in lichens, and the development of *fast dyes* from lichens capable of competing with the coal-tar and other recent products of the chemist's laboratory.

During the last twenty-five years the principal changes in our knowledge of the chemistry of these colouring matters consist in (1) the addition of sundry (supposed or really) new substances, confusing to a still greater degree the previous confusion of *names;* and (2) certain proofs of the correctness of the opinion, that several, at least, of the bodies described by different chemists as differing trivially in constitution are referable to the same substance. A new series of conjoint researches by competent chemists and lichenologists are therefore required. Not only are *new* fields of research open, but the need of a *revision* of all previous analyses is even more evident. Chemists themselves are forced to make this admission, but the subject has not as yet proved a sufficient counter-attraction to the innumerable other interesting problems daily exposed for solution in organic chemistry. Meanwhile, the crude researches of lichenologists may serve to pave the way for the subsequent more scientific and precise analyses of chemists, by indicating the *directions* in which chemical inquiry is likely to prove useful or successful.

The foregoing along with other considerations have induced Dr. Lindsay to submit the results of another more systematic and complete series of experiments, supplementary to those presented in 1853–5. These results include a general inquiry into colour-development in the whole family of lichens, and the experiments are on the one hand a repetition, and on the other an extension, of the former series, and illustrate generally the *colour-reactions* of lichens.

A *solution* of the lichen colorific principles was used in hot water or alcohol, boiling the lichens, previously reduced to powder or minute fragments, as the majority, at least, of the colouring principles, while insoluble in cold and sparingly so in hot water, are readily soluble in cold or boiling *alcohol.* The reactions developed are thus the effects of reagents on the *alcoholic or aqueous decoctions of the lichen-thallus.*

Whilst the specimens experimented on were for the most part comparatively *old*, a parallel series of experiments was made on *fresh* lichens in their own places of growth with, on the whole, similar results.

Dr. Lindsay has prepared a voluminous series of elaborate tables of details of his experiments which is not however yet published.

Microgonidia.*—Dr. J. Müller, of Geneva, replies to the objections brought forward by de Bary, and reasserts the correctness of the discovery by Dr. Minks of the "microgonidia" of lichens; which he states have now been detected also by nearly all the Geneva botanists; by Dr. Tuckermann, of Amherst, and by Herr Stodder, of Dorten, without any chemical preparation, and by Tolles' immersion-systems ($\frac{1}{8}$, $\frac{1}{10}$, $\frac{1}{18}$, and $\frac{1}{25}$). For the observation of the "microgonidia," Dr. Müller recommends immersion objectives, with Abbe's condenser, and an illumination of white light only reflected from white clouds, &c.

* 'Flora,' lxii. (1879) p. 294.

Algæ.

Formation of the Siphons and Tetraspores in Polysiphonia.*—Professor Wright considers the frond of *Polysiphonia* as not, correctly speaking, articulated or jointed. As regards the development of the central tube, in the living state there is no central cavity in the frond; but there is a central cell many times longer than broad, putting one in mind of a prosenchymatous cell, with four or more rays proceeding from about its central portion, and its two poles somewhat drawn out. In the early disk-shaped condition of the frond a division takes place, apparently simultaneously, into a central cell, and four others surrounding it in the form of a cross, the central cell being the smallest. As development progresses, the central cell or tube grows only in length, or, at least, very little in breadth; while the four surrounding cells grow both in length, width, and depth, forming ultimately what are known as the "siphons." The evolution of the tetraspores is very much the same as in *Griffithsia*.

Fertilization of Red Algæ by the Agency of Infusoria.†—Professor Dodel-Port, of Zurich, has communicated to 'Kosmos' an account of some exceedingly interesting observations made by him on the fertilization of a Floridean alga, *Polysiphonia subulata* T. Ag., which appears from his researches to present a singular combination of analogies with the anemophilous and entomophilous phanerogamous plants. An abstract of Professor Dodel-Port's paper, with figures, appears in 'Nature.'‡

Like many other Florideæ, *Polysiphonia subulata* is diœcious, and the male and female plants appear often to grow at a considerable distance apart. The antherozoids, which are produced from antheridia presenting a considerable external resemblance to microscopic ears of maize, are described as mere globules of protoplasm, containing a small, highly refractive nodule and a few plasma granules, but entirely destitute of cell-wall, and of the cilia by means of which the antherozoids of so many algæ make their way through the water in search of the female organs which they are destined to fertilize. The antherozoid is thus precisely analogous to the pollen-grain of an anemophilous phanerogamous plant.

The female reproductive organ in this plant is a multicellular body forming an outgrowth from the apical parts of the branches of the thallus. The youngest of these carpogonia is found nearest the apex, those lower down being more mature. The structure of the carpogonium is described by Professor Dodel-Port in detail, but the most important point for our present purpose is the presence at its summit of two hair-like organs—a forked hair composed of several cells, and a trichogyne, a slender, colourless, unicellular hair, a little shorter than the forked hair, and produced from the surface of the carpogonium at a later period, making its appearance, in fact, about the time when the unfertilized carpogonium arrives at maturity. When full grown, it

* 'Trans. Irish Acad.,' xxvi. (1879) p. 47.
† 'Kosmos,' 1879; see 'Pop. Sci. Rev.,' iii. (1872) p. 421.
‡ 'Nature,' xx. (1879) p. 463.

is of a cylindrical form, abruptly rounded off at the extremity, and its narrow interior canal is filled with colourless, finely granular protoplasm. The trichogyne is most important, as it is the receptive organ, analogous to the elongated style which occurs in so many phanerogams. Fresh antherozoids of *Polysiphonia subulata*, on coming into contact with the upper part of the trichogyne, which seems to some extent to act as a stigma, immediately adhere to it firmly, when the granular contents of the antherozoid pass into the interior of the trichogyne, and a part of them descending the canal in the latter reach the carpogonium, of which they fertilize the central cell. This process, as will be seen, is very analogous to that which takes place in phanerogamous plants.

In the case of anemophilous or wind-fertilized diœcious plants, it is well known that the chance of fertilization is usually greatly increased by the enormous quantity of pollen which the male flowers yield to every passing breeze, and a similar provision is found to prevail in the case of diœcious *Polysiphonia*. It is perfectly clear that the antherozoids of this plant, being quite destitute of any locomotive organs, must be passive in their further proceedings, and they are no doubt carried along in all directions by the currents and other movements of the water until, on meeting with the trichogyne of the female plant, they adhere to it, and fulfil their duty. When the two sexes grow at no very great distance apart, Professor Dodel-Port seems to think that the small marine animals, crustacea, annelids, starfish, infusoria, &c., which swarm in the submarine forests of Florideæ, may aid importantly in effecting the transportation of the fertilizing element to the female organ; but in the course of his investigations he discovered that certain minute animals interfere in the process in a much more curious and interesting fashion, vividly reminding us, indeed, in the singular adaptation of means to ends, of the wonderful relations unquestionably existing between insects and flowering plants. On the growing thallus, and especially on the youngest branches, Prof. Dodel-Port constantly found an immense number of the well-known bell-animalcules (*Vorticella*), which were, as usual with them, in incessant motion. These little creatures were found to feed upon the antherozoids floating about in the water; but besides those which they manage to swallow, a considerable number are whirled about in the vortex caused by the cilia of the animalcule, which no doubt stops them in the course impressed upon them by larger submarine currents, and keeps them, as it were, hovering about the neighbourhood where their business lies. As the *Vorticellæ* are constantly changing their position by the contraction and extension of their little foot-stalks, the whirls set up by them in the water must become very complex, and the best proof that the action of these little vortices upon the antherozoids is beneficial to the plant, is to be found in the fact that it was through their agency that the author was enabled to observe the attachment of the antherozoids to the trichogyne. The presence of the *Vorticellæ*, in fact, imparts to the passive antherozoids a motion analogous to that with which the ciliated sperm-cells of other Algæ are endowed. In the case of the *Polysiphonia*, the beneficial action of

the whirls produced by the *Vorticellæ* is supposed to be increased by the presence in the immediate vicinity of the trichogyne of the forked hair above mentioned. This hair, it is believed, will divide the whirls, and thus produce subsidiary whirls, tending directly to bring the antherozoids into contact with the trichogyne.

In his conclusion, Prof. Dodel-Port makes the following remarks:—"The total absence of active organs of locomotion in the antherozoids of Florideæ points to a common ancestor from which the different branches of the Florideæ have inherited the immobility of the antherozoids. During the differentiation of the red seaweeds many forms have no doubt died out in consequence of fertilization not taking place through the passivity of the male cells, while other forms have retired to localities which favour the process of fertilization by the active currents of the water in spite of the immobility of the antherozoids. It is well known that we now find most of the existing species of Florideæ on the coasts of the warmer seas, which are constantly washed by the waves; while the northern coasts, which are covered with crusts of ice during a great portion of the year, are very poor in red seaweeds. Future researches will have to show how far in many of these aquatic plants the differentiation of the genera took place in the direction of an adaptation to the small marine animals which inhabit them, and favour their fertilization in the way I have pointed out."

Cell-structure of Griffithsia setacea, and Development of its Antheridia and Tetraspores.*—Professor E. P. Wright has made a careful examination of this red alga, well known to all collectors of seaweeds. In regard to the process of formation of the antheridia and tetraspores, Dr. Wright observes, that at first they are hardly distinguishable; very early, however, the mass of protoplasm completely isolates itself in the former case, while in the latter it remains attached by a little pedicel of protoplasm, which was found in every species of *Polysiphonia* in which he watched the development of the tetrasporic fruit. After the mass of protoplasm is well formed, it divides into four parts. Although the antherozoids of the Florideæ are ordinarily described as motionless, Dr. Wright observed in those of *Griffithsia* an obscure amœboid movement, quite sufficient to enable them to cling to or even enter a trichogyne. Various other interesting points in the structure of the cells and in the production of the sexual and non-sexual reproductive organs are described.

Reproduction of Cutleria.†—A careful examination of *Cutleria* at the zoological station at Naples, has led Falkenberg to confirm in the main Reinke's statements ‡ as to its mode of fertilization. This is not effected by a "diffusion-current," but by the actual coalescence of a single antherozoid—presenting in this respect a contrast to *Fucus*—with the "receptive spot" of the oosphere. The attractive force of the oosphere on the antherozoid appears to extend over a distance of

* 'Trans. Irish Acad.,' xxvii. (1879) p. 27.
† 'Mittheil. Zool. Station Neapel,' i. (1879) p. 420; see 'Bot. Zeit.,' xxxvii. (1879) p. 510.
‡ This Journal, *ante*, p. 605.

several centimetres. The impregnated oospore germinates without any intermediate period of rest, and develops at once into a cellular filament; this condition being described by Reinke as that of the "resting larva." In this state Reinke believed he had detected the production of "secondary spores," which, however, Falkenberg regards as a pathological product. This condition is only of short duration; in six or eight weeks lateral branches are produced, differing altogether in appearance from the primary germ-plant, consisting of plates of tissue with marginal growth. At this stage the germ-plant perishes. The impregnated female zoospores (zygospores) do not, on germination, produce at once a *Cutleria*-thallus, but a second generation, consisting of flat creeping shoots, which develop as lateral branches from a primary "germ-foot," and which differ materially from the ordinary *Cutleria*-thallus, both in the direction of their growth, and in the position of the growing point.

The author considers the phenomena here described as a connecting link between the conjugation of similar zoospores (zoogametes), and the impregnation of a passive oosphere by mobile antheroids.

Conjugation of Ectocarpus.*—It is now some time since Thuret discovered, contrary to his first assertions in 1850, that *Ectocarpus* possesses unilocular sporangia (oosporangia), as well as multilocular sporangia (trichosporangia). The same authority is said to have proved later on that the zoospores issuing from either of these forms of sporangia germinate without any previous reciprocal contact. Janczewski and Rostafinski have obtained the same result; they say that no conjugation takés place, neither at the moment of the emission of the zoospores, nor during their germination.† Since that, however, Reinke has proved sexuality in the Ectocarpaceæ, and in *Zanardinia* and *Cutleria*. Areschoug had already previously observed the conjugation of *Dictyosiphon*, but by a method which gave room for some criticism. In *Acetabularia*, Strasburger has observed that the zoospores only conjugate when they issue from different sporangia. Goebel has proved analogous phenomena in *Ectocarpus pusillus*, which is frequently found in the Bay of Naples on the great algæ, particularly on *Codium tomentosum*. He has seen the zoospores of this species conjugate only when two neighbouring sporangia were open at the same time. The same is the case with *Ulothrix*, according to Dodel. There is, therefore, among the inferior cryptogams, a tendency to cross fecundation.

American Œdogoniaceæ.‡—Professor Wittrock, the chief authority on the Œdogoniaceæ, has monographed the American species, including twenty-three of *Œdogonium* and eight of *Bulbochæte*, seven species being altogether new. The family, as a whole, differs but little from its European aspect, all the American forms belonging to types which are also represented in Europe. Those of Greenland and other northernmost parts of America are identical with those of northern Europe; while those from the southern districts differ

* 'Bot. Zeit.,' xxxvii. (1878) pp. 117, 193.
† 'Soc. des Sci. Nat. de Cherbourg,' 1873; Ibid., 1875, p. 9.
‡ 'Botaniska Notiser,' Nov. 5, 1878; see 'Bot. Zeit.,' xxxvii. (1879) p. 312.

specifically from those of the south of Europe. The genus *Bulbochæte*, in America as in Europe, has most representatives in the northern and north temperate zone.

New Genus of Chroolepidæ.*—Dr. Reinsch has detected a new genus of algæ, to which he gives the name *Acroblaste*, and which he refers to the family of Chroolepidæ, attached to small mussels belonging to the genus Turritella, and to small stones, on the coast of Buzzard's Bay, west of Cape Cod, North America.

The individual plants are microscopic, and form small green tufts, resembling at first sight an *Ectocarpus*, the larger plants being copiously branched. The characteristic reproductive organs, agreeing in their origin and the development of their cell-contents with the conceptacles of *Chroolepus*, are always formed at the apex of the filaments, the zoospores being produced in them. The mode of growth of the filaments resembles that of *Cladophora*. While at present placed among the Chroolepidæ, the author thinks it possible that the discovery of sexual reproductive organs may hereafter show *Acroblaste* to form a connecting link between this family and the Phæosporeæ.

Fossil Algæ belonging to the Verticillate Siphoneæ.†—Munier-Chalmas includes under this section of calcareous algæ all the Chlorosporeæ comprised by Harvey in the family Dasycladeæ, and all those fossil genera related to *Larvaria*, *Clypeina*, *Polytrypa*, *Acicularia*, *Dactylopora*, and *Uteria*, many of which have hitherto been mistaken for foraminifera. The group includes more than fifty genera, mostly found in the Triassic, Jurassic, Chalk, and Tertiary formations. It is at present represented only by seven living genera, viz. *Dasycladus*, *Halicoryne*, *Cymopolia* (including *Polytrypa* and *Descaisnella*), *Polyphysa*, *Acetabularia*, *Neomeris*, and *Bornetella*; the last a new genus founded on Harvey's *Neomeris nitida*, distinguished by the origin of the sporangia at the side of the radiate threads, instead of at the apex in the centre of the terminal pileus.

The frond of the verticillate Siphoneæ is simple or dichotomous, formed of a tubular axis, from which spring successive whorls of radiating branches. In many species the axis as well as the rays have their wall encrusted with calcium carbonate, so that the plant is enclosed in a calcareous envelope, which reproduces with exactitude the details of its organization. This inorganic envelope consists of one or two calcareous cylinders. The inner one is formed of the axis and the first member of the verticillate rows of cells which spring from it. The outer cylinder is composed of the outermost cells of the branches which end in an enlarged swelling, the lateral margins coalescing with those of the neighbouring ones. The fructification may also be encrusted with lime, and contribute to the formation of the outer cylinder, as may be seen in the genus *Cymopolia*. The fructification sometimes consists of single receptacles or sporangia, as in *Cymopolia* and *Necmeris*, sometimes of a number of smooth shining hollows in which sporangia or spores are formed, as in *Acicularia*, *Maupasia*, *Dac-*

* 'Bot. Zeit.,' xxxvii. (1879) p. 361.
† 'Comptes Rendus,' Oct. 29, 1877; see 'Bot. Zeit.,' xxxvii. (1879) p. 165.

tylopora, &c. In the fossil forms a calcareous skeleton remains, very liable to be confounded with that of foraminifera, in which are hollow chambers and canals, where the fructification and the rays have been, and by means of which they may be determined with great ease.

The author thus classifies the genera belonging to the group. Those marked thus * are fossil genera; those marked * * are known in both the fossil and living state:—

I. Cymopolidæ	1. Dasycladus. 2. Halicoryne. 3. Clypeina.* 4. Cymopolia.** 5. Parkerella.* 6. Hermitella.*	A. Decaisnella.** B. Larvaria.* C. Vaginopora.* D. Karreria.* E. Polytrypa.**
II. Acetabularidæ	7. Polyphysa. 8. Acetabularia. 9. Acicularia.* 10. Briardina.* 11. Orioporella.*	
III. Thyrsoporellidæ ..	12. Thyrsoporella.* 13. Gumbelina.*	
IV. Dactyloporidæ	14. Dactylopora.*	
V. Neomeridæ	15. Neomeris. 16. Bornetella.* 17. Terquemella.* 18. Maupasina.* 19. Zittelina.*	
VI. Uteridæ	20. Uteria.*	
VII. Hagenmulleridæ ..	21. Hagenmulleria.* 22. Carpenterella.*	

Influence of Light on the Movements of Desmids.*—According to Stahl, when *Closterium* is placed in a vessel which the light reaches only from one side, the cells attach themselves to the glass in such a position that the longer axis of the cell coincides with the direction of the incident light. If the direction of the light is altered, the position of the cell varies correspondingly with more or less rapidity. There appears, therefore, to be a certain difference between the two halves of the cells in respect to their behaviour towards light, one extremity seeking and the other avoiding it. It is remarkable that in this respect the properties of the two halves seem to alternate from time to time, causing a change in the direction of the longer axis to the extent of 180°. Intense light appears to have a very different effect on desmids to that of diffused light, the cells then placing themselves in a position in which the longer axis is at right angles to the direction of the incident light.

New Diatom.†—A new genus and species of diatom from the Santa Monica deposit is described by Mr. Stodder; the following are given as the generic and specific characters:—

"*Discus* (a plate), n. g. It is a simple disk, translucent like

* 'Verh. Phys.-med. Gesellsch. Würzburg,' xiv. No. 7; see 'Hedwigia,' xviii. 1879, p. 100.
† 'Am. Journ. Micr.,' iv. (1879) No. 3.

porcelain, with no dots, puncta, or striæ, or other marks common to diatoms.

"*D. porcellaneus*, n. s. Characters that of the genus, with a ridge submarginal, giving it the look of a dinner-plate; other examples have a curved ridge in some (not constant) part of the disk."

Adulteration of Currant Jelly with Diatoms.* — Professor Ch. Menier, of Nantes, in examining with the Microscope some so-called currant "preserves," recognized that the gelatinous consistency was due to diatoms, as was evidenced by the presence of a very fine *Arachnoidiscus japonicus*.

Professor Menier then procured some of the substance (used for various industrial purposes) known as Chinese or Japanese glue, and discovered the same diatom. This is not found in France, and he was thus able to establish the actual composition of the "preserve." The colour he found to be due to cochineal and hollyhock, as was shown by the presence of large pollen-grains of the Malvaceæ. The preserve would not, of course, keep long, being quickly invaded by cryptogamic productions.

Professor Menier points out that the Japanese glue is "a very easy and valuable substance for diatomists to explore, and in which discoveries will probably be made." According to him it is manufactured out of the Algæ of the Japanese coasts that are capable of being transformed into jelly—at any rate, the débris of a number of very different Algæ are found. M. Bornet considers them capable of being identified.

Palmelline, the Colouring-matter of Palmella cruenta.† — M. Phipson has subjected to careful examination the colouring matter of this minute alga, often found as a red stain at the bottom of walls, &c., especially in winter. Under the Microscope, it is seen to consist of minute globules, about 4 μ in diameter, closely resembling globules of blood, which have a diameter of 5 to 6 μ. They float freely in a mucous fluid not unlike the serum of blood.

The colouring matter of these globules, to which the author gives the name *palmelline*, presents a remarkable resemblance to the hæmoglobin of blood. It is insoluble in alcohol, ether, benzin, bisulphide of carbon, &c., but dissolves in water; it is dichroïc, composed of a red substance combined with an albuminous substance, and coagulates with alcohol, heat, and acetic acid. Its spectrum shows one or two absorption-bands in the yellow, or between the yellow and green. Like hæmoglobin, it contains iron, the residue on evaporation presenting distinct indications of lime, chlorine, and iron. Various other interesting properties of this substance are described by the author in his original paper.

Mycoidea parasitica, a new Parasitic Alga.‡ — Dr. Cunningham describes under this name a new genus of parasitic Algæ, very destructive to the leaves of camellia, rhododendron, and other plants in India.

* 'Bull. Soc. Bot. France,' xxvi. (1879) Rev. Bibl., p. 66.
† 'Comptes Rendus,' lxxxix. (1879) p. 316.
‡ 'Trans. Linn. Soc. (Bot.),' li. (1879) p. 301.

The parasite makes its appearance in the form of greenish or bright orange patches on the upper surface of the leaf. On detaching one of these pustules from the leaf, and examining it under high powers, it is found to consist of a flattened, subepidermal disk of radiating filaments, from which numerous ascending twigs arise, and these, breaking through the epidermis, develop into the fructifying filaments. The disk consists of a single layer of dichotomous filaments, and increases continually at the margin. The terminal cell of a fructifying filament eventually swells up into an oval, spore-like body; in this is ultimately formed a roundish orifice, from which escape a number of reddish orange (by transmitted light) biciliated zoospores. The sexual reproduction is effected by the fecundation of oogonia by pollinodia. The resulting oospores retain their vitality for a considerable time. Ultimately the contents break up into a number of biciliated zoospores, precisely resembling those produced non-sexually. They rupture the thin wall of the oospore, and swim freely in the subepidermal space and over the surface of the leaf.

With regard to the systematic position of *Mycoidea*, Dr. Cunningham considers that, notwithstanding the difference in the mode of reproduction, its vegetative structure indicates a near affinity with *Coleochæte*. An interesting circumstance connected with this alga is that a number of the primary disks do not give rise to fructifying filaments, but are utilized by fungal filaments, and, in connection with them, contribute to the development of patches of a heteromerous lichen.

Two new Parasitic Algæ.* —An addition is made to the small number of known parasitic Algæ in the description by J. Reinke of two species.

The first, a species of *Anabæna*, was discovered by him several years ago in the roots of Cycadeæ, where it forms bright green streaks visible to the naked eye. It develops in the intercellular spaces, but has no obvious injurious effect on the host. Microscopic examination shows it to consist of strings of globular cells embedded in jelly, presenting a close resemblance to *Nostoc*. It has been observed in the roots of *Ceratozamia*, *Cycas*, *Dioön*, and *Encephelartos*.

The second species, to which he gives the name *Entocladia viridis*, is parasitic on the long unicellular filaments of *Derbesia Lamourouxii*, growing, however, not within the cell, but in the cell-wall. It is a branched, multicellular, filamentous alga, nearly allied to *Stigeoclonium* and *Chlorotylium*. Although no reproduction of the alga has been observed, this no doubt takes place by means of zoospores.

Method of Cultivating Volvox globator.† —This Alga is, according to the experience of many, a most difficult one to keep for any length of time, but Mr. N. E. Brown, of Kew, announces that he has discovered the way to do so.

For several years his practice was to place the *Volvox* in large glass or earthenware jars, small bottles, open dishes, and other vessels, exposed to full sun, or kept in partial or entire shade,

* 'Bot. Zeit.,' xxxvii. (1879) p. 473.
† 'Gardeners' Chronicle,' 1879 (Nov. 8) p. 599.

supplying it with rain, pond, and spring water, in turn, but always with the result that after a short time it disappeared. In October, 1878, however, he put a small quantity, probably not more than one hundred individuals, in a four-ounce bottle, having a mouth three-quarters of an inch in diameter, and set this on a shelf at the side of an outhouse, which had no gutter, so that the rain in running off the roof would drip into the bottle; here it has remained until November 1879, and instead of the few original specimens, they are now abundant. The water has never been changed or replenished, only that which dripped naturally from the roof into the bottle having been added to the original stock, and during the abundant rains of this year the bottle often overflowed. Several times a portion of the water containing the *Volvox* has been placed in the jars and dishes standing in various parts of the garden, but these always died in a short time, whilst those left in the small bottle, treated as above, remained in perfect health and multiplied. The position in which the bottle was placed faced the north, so that it only got the sun in the early morning of the summer months. During the severe weather of last winter, the water was several times frozen into a solid mass of ice, but apparently without injuring the *Volvox*.

MICROSCOPY, &c.

Soap as an Embedding Substance.*—Some of the chief objections to the methods of embedding in oleaginous or waxy mixtures seem to be successfully met by the use of the preparation recommended by Dr. Kadyi, and its capability of modification according to the different substances to be embedded is strongly in its favour.

The best materials and proportions are as follows:—28 grammes of shavings of stearate of soda soap (that sold as "weisse Wachskernseife" abroad is best), 100*g*cub. cent. of 96 per cent. alcohol, and, generally, 5 to 10 cub. cent. distilled water. The two first ingredients are warmed together on the water bath and to the liquid mass the water is added gradually, until it coagulates quickly into a transparent mass when dropped into a watch-glass. The mixture should be kept in a stoppered bottle.

For use, it is melted or boiled and the object at once plunged in. When cool, sections of it are taken with a razor wetted with strong alcohol, this liquid being also used, warm or cold, to dissolve out the soap from the sections.

Thus used, the material is adapted best to delicate objects; it possesses transparency and elasticity, and penetrates pores and cavities effectually.

A tougher preparation, suited to harder, such as chitinous, tissues, is obtained by increasing the proportion of soap to an almost equal amount by weight with that of the alcohol.

Logwood Staining Solution.†—Dr. E. A. Cook points out that in most text-books this is stated to be good in results but uncertain in action; and from the numbers of formulæ given for its preparation,

* 'Zool. Anzeiger,' ii. (1879) p. 476.
† 'Journ. Anat. and Phys.' (Humphry), xiv. (1879) p. 140.

it is evident that many experimenters have failed to hit upon a combination satisfactory in all points. The chemical nature of the colouring material of logwood is fairly stable, and affords no reason for any uncertainty, and it appeared desirable therefore to determine under what conditions the solution would yield the best results.

The colouring material consists of two substances—hæmatoxylin and hæmatein, differing by two equivalents of hydrogen. Hæmatoxylin (containing the larger amount of hydrogen) is soluble in alum solution, while hæmatein is slightly, if at all so. The latter is of no use for colouring animal tissues. Hæmatoxylin forms compounds with various metallic oxides which are soluble in alum solution also; and if a tissue be stained with hæmatoxylin, or with hæmatoxylin and a metallic oxide, and immersed in an aqueous solution of alum, the colour will be all discharged from the tissue and taken up by the solution; and the solution will thus take up fresh quantities of hæmatoxylin compound until it reaches a point of saturation beyond which it will take no more from tissues, but will, if over-saturated with it, give up the colouring matter freely to immersed animal material. Such a solution of hæmatoxylin, alum, and metallic oxide has a clear purple colour, becoming red on addition of acids. If alkaline earths, alumina, or hydrated earthy phosphates be suspended in it, they will absorb the colour, and the solution becomes purple. If the solution be treated with a very small percentage of a chromate, the purple will gradually be replaced by a yellowish-brown colour; or if a tissue which has been stained with alum-logwood solution be immersed in an exceedingly dilute bichromate solution, the purple will sooner or later be replaced by the yellow tint. If a section of any abnormal caseous concretion or abnormal growth be immersed in a neutral solution of alum-logwood, it will become of a more bluish purple than ordinary tissue, evidently from the presence in it of more than an ordinary amount of alkaline earthy matter or phosphate.

When the above facts are taken into consideration, it will appear unreasonable to expect tissues hardened in chromic solutions of any kind to colour as readily with an ordinary logwood solution as they would do if immersed in the fresh state. Sections of chromic-hardened tissues are exceptionally difficult to free from chromic compounds most probably because part of the chromic acid is in chemical combination and insoluble, and when freed from the hardening material the tissues will not be left in the natural neutral state, and thus less readily will the nuclei take up the colour. But it has been found that hardened tissues if cut into sections and well washed, may be as readily stained with logwood as fresh tissues if the solution be slightly modified.

It has been found that the cheapest and most practical logwood solution may be made as follows:—Take logwood extract, 6 parts; alum, 6 parts; sulphate of copper, 1 part; water, 40 parts. All ingredients must be free from iron. Grind the alum, logwood extract, and sulphate of copper in a mortar, and when powdered add sufficient water to form a thin paste; leave for one or two days with occasional stirring and then filter. The hæmatein contained in the

logwood extract will be retained by the filter with the dirt, and the solution consists of hæmatoxylin, alum, and sulphate of copper, to which a crystal of thymol may be added to preserve it from mould. Fresh or alcohol-hardened tissues may be stained with this after sufficient dilution; but for chromic-hardened tissues, dilute 8 drops with 120 drops of water, and add one drop of $\frac{1}{10}$ per cent. solution of bichromate of potash just prior to use. Wash the stained solutions in water as usual. A larger proportion of bichromate solution will produce an ugly yellow; and if the mixed solution be kept many hours, some decomposition will go on.

Tissues stained in logwood may be mounted in glycerine or Farrant's solution or in dammar. In the two former they keep unchanged for any length of time; in the latter they are apt to fade unless care be taken, in preparing them for dammar, that the sections be thoroughly freed from water by absolute alcohol before being brought into contact with oil of cloves. If any moisture be left, fading will soon commence, and the preparation be spoiled.

Modification of Farrant's Medium.*—Professor P. Langerhans finds the following a very satisfactory modification of Farrant's medium for microscopical preparations of small animals:—Gummi arab., 5; aquæ, 5—to which after twelve hours add, glycerini, 5; sol. aquosa acid. carbol. (5 p. c.), 10.

With living marine animals it is only necessary to use enough to go under the cover-glass, and to add a little on the following day to make up for evaporation, and the preparation is then ready. The shrinking is very slight, and even many colours are preserved.

Staining Fluids for Vegetable Tissues.†—Mr. A. H. Barrett recommends the following as a simple and successful method of staining one section with two fluids.

The section is first immersed in an aqueous (1 per cent.) solution of Crawshaw's aniline blue dye. It is then removed into strong acetic acid, which seems to fix the colour in certain tissues, remove it from others, and prepare that not stained for the reception of another colouring fluid. It is then again removed into a weak solution of magenta (Judson's dye), also made strong with acetic acid; then mounted in glycerine jelly. The process effectually shows the "differentiation" of parts, both by the different colours and the varying intensity of colour.

The following are the colours with which the tissues of a section of Burdock are stained:—

Pith	Very pale magenta.
Cellular tissue	Deep magenta.
Spiral vessels of medullary sheath ..	Deep blue.
Pitted vessels	Blue.
Cambium	Deep blue.
Liber cells	Dark magenta.
Laticiferous vessels	Deep blue.
Cuticle parenchyma	Pale blue.
Epidermis	Deep blue.
Hairs	Pale magenta.

* 'Zool. Anzeig.,' ii. (1879) p. 575.
† 'Science-Gossip,' 1879, p. 255.

Chloride of Cadmium as a Fluid for Homogeneous Immersion.*—Colonel Woodward expresses his approval of one of the new immersion fluids proposed this year by Professor Abbe,† viz. the chloride of cadmium dissolved in glycerine, and sends photographs of *Amphipleura pellucida* taken with the Zeiss $\frac{1}{12}$ and Tolles' amplifier, both with cedar oil and with the cadmium solution. The last picture, as he points out, resembles that taken on the same day with the cedar oil almost as closely as if the two were prints from the same negative. The cadmium solution is not only convenient for use with objectives of considerable focal length (as the $\frac{1}{8}$ of Zeiss, for example), but is especially desirable for photography, as it cannot attack the balsam cement of the front lens of the objective. This he finds the oil of cedar may do. Slowly as it attacks solid balsam when cold, it appears to act more energetically when the temperature is somewhat raised, as happens during micro-photography. In the case of the Zeiss $\frac{1}{8}$ belonging to the Army Medical Museum, the oil of cedar has already in this way penetrated to the space behind the front lens of the objective, which he has in consequence been obliged to return to the maker for repairs. The substitution of the new fluid appears therefore to have advantages for photographic purposes which are well worthy of consideration.

Scientific Value of Microscopic Preparations.‡—Dr. Pelletan, of Paris, complains of the small scientific value of the majority of microscopic objects prepared for sale, though they are often very beautiful in appearance; the preparations of diatoms being alone, for the most part, satisfactory, often excellent, and sometimes marvellous. Certain preparations of cryptogamic botany are also, he considers, of value, and dissections, &c., of vegetable anatomy, thin cuttings of dense substances, animal, vegetable, and mineral, and particularly sections of wood, but of all other classes it is only by chance one meets with an interesting slide.

Many of the ordinary preparations, however, if not satisfactory to *savants*, interest *amateurs*, and they teach many things that otherwise would not have been known. "They are also useful in England, where they are sold in large numbers, because in that country the Microscope is more used for amusement and as an object of luxury than for working purposes. These slides, that for us have little interest, are therefore in this point of view of real utility. They give to ordinary people the taste for natural objects, and they furnish a thousand little instructions acquired without labour, and are also amusing. We must not, therefore, too much despise them.

"Histological preparations, whether normal or pathological, are those of least value. Preparers, with very few exceptions, have not sufficient knowledge of histology or of the necessary technical methods, or even the will to adopt them, because they are tedious and delicate, and, moreover, it is feared that the increased cost of the preparations would frighten those who might wish to acquire them. There is no foundation for this last reason, judging from the daily demands for

* See *post*, p. 988. † See *ante*, p. 346.

‡ 'Journ. de Micr.,' iii. (1879) p. 139. Translated in full in 'Science-Gossip,' 1879, No. 179, p. 250.

preparations made on these principles, even at an increased cost, when they are really instructive, and it cannot be doubted when we see the most common specimens of *Pediculus pubis* sold in America for 5 fr. 75 c., in which country it is not rarer than it is in France."

Counting of Blood-corpuscles.* — Professor Abbe has recently published a paper on this subject, in which he refers in the first place to an apparatus, the plan of which was suggested by Mr. R. Thoma, of Heidelberg. It presents no special novelty in design, its value consisting rather in the appropriate adaptation of the best means known, and the careful technical construction by which the faults of the measuring apparatus are kept within narrow limits, so that they may be neglected in practice.

The leading features are—(1) the method of mixing the blood so as to dilute it in a simple known proportion, and (2) the special apparatus for counting which enables the microscopist to take a determinate volume of the diluted blood fluid. For the first Malassez's mixer is used, modified so as to facilitate the purifying and to keep the consistency constant. The capillary tube holds about 6 mgr. of blood; its volume, which is taken as unity, is made the one-hundredth part of the volume of the mixing bulb (exact to about 0·5 per cent.). The correct length of the capillary is determined from data as to the capacity of the tube and mixing bulb, obtained by weighing, water being used for the latter instead of quicksilver, as on account of the glass ball used for mixing, a non-adhering fluid would not properly fill out the space.

For counting, an adaptation is made of Hayem's chamber, which consists of a slide to which a thin glass plate with a circular hole is firmly cemented and ground down parallel to the surface of the slide, so that a superposed flat plate would enclose a stratum exactly 0·1 mm. deep. For cutting off a definite volume of this stratum, instead of a micrometer in the eye-piece of the Microscope, Gower's method is adopted, and divisions are cut on the bottom of the chamber, so that a square millimetre is divided into small squares, the sides of which are 0·05 mm., and the area $\frac{1}{400}$ square mm. As the blood-corpuscles in the artificial serum of Malassez sink to the bottom in a few moments, the contents of a thousandth of a cubic millimetre in the field of the Microscope may be readily counted, being the contents of any four of the divisions. When normal blood is diluted in the proportion of 1 : 100, about fifty blood-corpuscles are found in this space, and the number being multiplied by 100, gives the contents of the thinned blood per thousandth cubic millimetre, which furnishes figures convenient for comparison.

The divisions on the bottom of the counting apparatus are a great advantage over the eye-piece micrometer, as they avoid the necessity of ascertaining the value of the divisions of the latter, which of course varies with the objective and length of the tube; a fruitful source of errors is avoided, and complete freedom is obtained in the choice of objectives and magnifying power.

* 'SB. Jen. Gesell. Med. und Nat.' (1878).

The apparatus is so delicately constructed that, if carefully manipulated, the errors in measuring will never exceed about 1 per cent.

The mathematical theory by which the probable extent of the error of counting is determined may be briefly summarized as follows. If n denote the average number of blood-corpuscles to a given space, the relative frequency of other numbers is expressed by the respective terms of the expansion of e^n (where e denotes the base of natural logarithms) divided by the complete value of e^n. Thus, the probability that k corpuscles will appear instead of n is,

$$W_k = e^{-n} \frac{n^k}{1 \cdot 2 \cdot 3 \ldots k}.$$

Making $k = n + \Delta$, where Δ expresses the deviation, positive or negative, from the average number, the above expression becomes approximately

$$W_\Delta = \frac{1}{\sqrt{\pi}} \frac{1}{\sqrt{2n}} e^{-\frac{\Delta^2}{2n}}.$$

Consequently, the "probable error," that is, the error which in repeated observations would be as often exceeded as not reached, may be expressed as a function of n, or, calling this error w,

$$w = 0 \cdot 4769 \sqrt{2n}.$$

If the ratio of this probable deviation to the average number be denoted by ω we get

$$\omega = \frac{0 \cdot 674}{\sqrt{n}}.$$

In a large number of observations, if ω denote the probable error, then, according to the laws of probability,

An error	less than	$\frac{1}{4}\,\omega$	occurs	once in	every	7 cases.
,,	,,	$\frac{1}{2}$,,	,,	,,		4 ,,
,,	,,	1 ,,	,,	,,		2 ,,
,,	greater than	1 ,,	,,	,,		2 ,,
,,	,,	2 ,,	,,	,,		5–6 ,,
,,	,,	3 ,,	,,	,,		23 ,,
,,	,,	4 ,,	,,	,,		160 ,,
,,	,,	5 ,,	,,	,,		1,385 ,,
,,	,,	6 ,,	,,	,,		20,000 ,,

and hence may be directly deduced what reliance is to be placed on the result of a single observation, that is, what approximation to the correct average value may be safely expected when the value of ω has been computed from the above formula, suited to the conditions of the particular observation.

The above formula for ω shows that the probable error expressed as a percentage of the average number decreases in the same proportion as the square root of the average number increases. Thus, the value of ω is reduced to about 5 per cent. if n is made to equal 200, that is, when the counting extends over a volume of four thousandths of a cubic mm. or to sixteen fields of the micrometer, and

the result of this would be that an error of 10 per cent. would have the probability of one-fifth. ω would fall to 2 per cent. if the counting were extended to 1250 or 100 squares, and the probability of an error of 4 per cent. would be one-fifth. An error of 6 per cent. would have the small probability of only one-twenty-third, and an error of 10 per cent. might be expected to occur once in 1400 cases, which is as good as being excluded altogether.

Moreover, the limitation of the probable error to 1 per cent. would be ensured by extending the number counted to a total of about 5000, which, under the conditions here assumed, would correspond to the contents of the whole square millimetre. In this case, therefore, the mean value may safely be assumed as true to within 2 to 3 per cent., because an error of 4 per cent. would occur once only in 160 cases.

This method of judging of the exactness of the results is capable of being applied to various other scientific investigations of the same kind.

Cheilo-angioscopy.*—This name is applied by Dr. C. Hueter to his new process for the direct observation of the circulation in the human subject.

The apparatus consists of a frame, something like that used by photographers, for supporting the head of the person under observation, and having attached to it a stand on which a microscope and lamp are supported. The patient's lower lip is drawn out, and fixed with clips on the stage of the microscope: a strong light is then concentrated on its inner surface by means of a condenser, and it is examined by an objective of low power, the superficial vessels which can be seen even with the naked eye being brought into focus.

The vessels look, at first, as if filled with an opaque red injection; but with a little practice and careful focussing, the observer is soon able to make out the movement of the blood stream, and even to distinguish the red and the colourless corpuscles. The epithelial cells of the mucous membrane, and the apertures of the mucous glands, may also be seen.

By the application of slight pressure to the lip, the phenomena of venous stasis may be studied: it is also easy to observe the effect of cold, by touching the lip with ice, or that of innocuous reagents, such as glycerine or ammonia. The various pathological conditions of the circulation, characteristic of certain diseases, are also easily studied with complete accuracy.

Hueter remarks that the pathological observations he has already made by means of cheilo-angioscopy, prove conclusively the importance of the new process: a good deal of practice is, however, necessary, before it can become clinically useful.

Value of the Microscope in Law and Medicine.—Dr. R. H. Ward, of Troy, N.Y., in his able presidential address † at the opening meeting of the American Society of Microscopists, held at Buffalo in August last, deals at some length with the legal uses of the Micro-

* 'Cblt. med. Wiss.,' Nos. 13 and 14 (1879).
† 'Buffalo Daily Courier,' Aug. 20, 1879.

scope, "a department so large that it might almost be regarded as a new science, under the title of 'Microscopical Jurisprudence.'" The determination of hand-writing is more particularly referred to.

The 'Bulletin Scientifique du Département du Nord' also contains an article on the use of the Microscope in medicine, especially pathological histology.*

It is not possible usefully to give an abstract of either paper.

Unit of Micrometry.—In his address mentioned above, Dr. Ward says with regard to the resolutions of the Indianapolis Congress of 1878, that "as too often happens, their incidental faults attracted more attention than their really scientific object. The unit proposed ($\frac{1}{100}$ mm.) was evidently too large for integers, and too short for fractions, and unlikely to receive a single approval either at home or abroad; and the proposal of international action, though its object was universally approved, was in a form not likely to accomplish that object."

The new committee appointed by the various Societies (see p. 154) has not yet made its report

Comparators for Measures of Length.†—Professor W. A. Rogers has devised a comparator of the design shown in Fig. 1 to remedy the defects found to exist in the eye-piece and filar micrometer as well as in the Merz stage micrometer (A *a*).

The comparator proper consists of a bed-plate, within which is fitted a slide carried by the precision screw *b*. The object to be measured is held in position upon the moving plate by the clips shown in the figure. Instead of two parallel springs there is a single cord attached to the centre of the moving slide which runs on the guide pulley *d*, and is attached to a spring which is fastened to a pin on the back side of the bed a little to the right of and below *b*. The action of the spring, therefore, is wholly in the line of the screw, and as the direction of the cord falls a little below the motion of the slide, it has a slight tendency to keep the slide in contact with its seat without introducing friction. The screw *e* moves the whole bed-plate, including the precision screw *b*. The whole comparator has a circular movement in the socket *f* attached to the origiual substage *e* of the Microscope. The filar micrometer is shown at *h*, and an eye-piece with a micrometer, having some advantages over the usual form, is shown at *i*. Slow motion to the tube is given through the lever *g*.

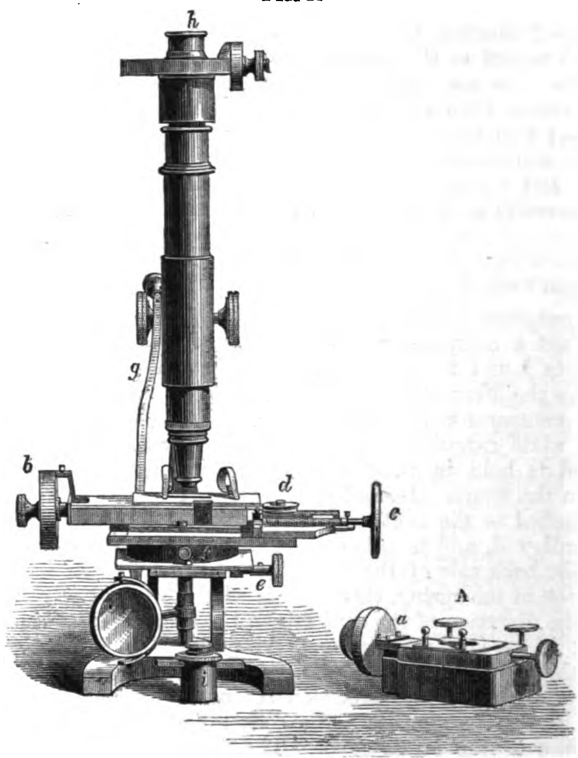
The operation of using the comparator is as follows:—

After the slide containing the graduations to be compared has been placed in proper position under the objective, with the right hand, the screw-head *b* is set at the zero of position; with the left hand, line 1 is brought in contact with a single line of the eye-piece micrometer; with screw-head *b*, line 2 is brought in contact with the fixed line of the eye-piece micrometer, and the number of revolutions and parts of a revolution are read off. Screw *b* is then brought back

* Cf. 'Bull. Soc. Belg. Micr.,' v. p. 243.
† 'Am. Quart. Micr. Journ.,' i. (1879) p. 208.

to zero, and the setting is made on line 2 by means of the screw c. In moving over the space from line 2 to line 3 with the screw b, it will be seen that *the same part of the screw is used as in going from line* 1 *to line* 2. Hence the comparison of these two spaces is *independent of the errors of the comparing screw.*

FIG. 1.



The number of spaces which can be compared in this way is only limited by the length of the screw c, and the length of the opening through the bed-plate.

Again, suppose we measure the spaces 1, 2, 3, 4, . . . 100 by a continuous forward motion of the screw. Such measures will involve all the errors of the screw itself. But if after the measures are made we set the screw b back at zero, turn the ruled plate around 180°, and set on line 100 with screw c, the continuous forward motion of the screw b from line 100 to line 1 will be over the same part of the screw as from line 1 to line 100. In the first case the screw measures the accumulated errors of the ruled plate from line 1 to any point up to line 100, but such measures involve the errors of the comparing screw. In the second case the accumulated errors are

measured in the same way from line 100 to line 1. But if we subtract the measures from line 1 to line 100 from the corresponding measures from line 100 to line 1, *the difference will give twice the accumulated errors at any point for strictly periodic errors independent of the comparing screw.* The only exception to this rule is found when the curve of errors takes a wave form. In a general way this will be the case when the maximum error falls near line 25, and the minimum near line 75.

As an an illustration of the character of the work which may be done with a comparator of this form, Professor Rogers gives a Table of the measures of five standard micrometers ruled at different times. As these micrometers are somewhat different in form from any with which he is acquainted he gives a brief description of them.

1. A half-inch is divided into 50 equal parts, the 1st, 25th, and 50th spaces being again subdivided into 10 equal parts. The length of the lines is about $\frac{1}{8}$ inch, the 5th and 10th lines being a little longer.

2. After arranging the position of the ruling carriage, so that the lines of the second series of graduations should begin near the point where those of the first end, coincidence is made mechanically with the first line of the series already ruled. For a short distance the ruling point goes over the same ground twice. A centimetre is then subdivided into 10 equal parts. The 1st, 5th, and 10th spaces are again subdivided into 10 equal parts, and one of the middle subdivisions is still further subdivided, giving ·01 mm. Near by is a band of 21 lines, each space being equal to ·001 mm.

The table shows that the individual errors of graduation are practically insensible.

The errors obtained are, it is to be noted, entirely relative errors. They give no indication whatever of the absolute value of any of the spaces measured. If the entire length of the half-inch is e.g. ·001 inch too long, to each of the corrections given in the table must be applied still further the correction ·00002 inch.

It is therefore necessary to make a careful investigation of the entire length of the half-inch and of the centimetre.

This is done with a comparator adapted to the comparison of spaces, ranging from coincidence to an entire yard or an entire metre. Comparators of this class are usually constructed with two sliding plates, each carrying its own Microscope. A fundamental objection to this form is found in the fact that the Microscopes cannot be brought much nearer together than 3 inches by any direct means. For want of space and of illustrations, Professor Rogers is able to give only a general description of the form which he has had constructed.

It consists of an iron bed 60 inches long and 14 inches wide. V-shaped grooves 6 inches apart run the entire length. In the centre of the bed a fine-toothed rack reaches from end to end. Two sliding plates are carried along the ways by means of a pinion set in the centre of the plates and working so loosely in the rack that the slides are free to follow the law of gravity. A Microscope is

attached to each plate, giving the form usually adopted. Instead of two Microscopes, however, it is found better to use but one. The Microscope plate is followed on the other side by plates terminating in tempered steel tops which are at will either made free or clamped firmly to the bed of the comparator. If one wishes to compare two metres the method of proceeding is as follows:—

(a) One stop is set at or near one end of the bed.

(b) The metre with which comparison is to be made is placed in position under the Microscope so that contact is made between the end line and the zero line of the eye-piece micrometer.

(c) The microscopic plate is then moved by means of the rack and pinion till the other end line forms contact with the zero line of the micrometer

(d) The second stop is then brought up against the other end of the plate and adjusted so that when contact takes place between the stops, contact also takes place between the end line and the zero line of the micrometer.

(e) Having made the adjustment of the stops perfect, the metre to be compared is then placed in position. When contact is made with the first stop by mechanical adjustment the end line is brought in contact with the zero line of the micrometer. The Microscope plate is then brought into contact with the second stop. If the other end line is now in coincidence with the zero line of the micrometer the two metres have the same length. By noting the number of divisions which the end line falls short of or passes beyond the zero line of the micrometer, the difference in the entire length can be found, the only element yet unknown being the value of one division of the micrometer.

After the comparison has been made it is better, as a matter of precaution, to again compare the standard with the distance between the stops. Since the stops can be set in actual contact with the Microscope plate at either end it is obvious that this method admits of a comparison of short spaces as well as of long ones. The only criticism which it is imagined will be urged against this form of construction is that founded on a doubt whether the contact between the stops always indicates the same measured space. The arm of the pinion has a head of about 2½ inches in diameter. In his own case the sense of touch has been so far cultivated that he is able to make 100 successive contacts without a single deviation exceeding ·000035 inch, and very few deviations reach ·00001 inch. A comparator of this form possesses one decided advantage over all others, viz. that after the stops are once set *any adjustment of the Microscope may be made without interfering with the comparison.* The only condition required is that the relation between the stops and the bed shall remain unchanged during the short time required for the comparison. This does not usually take over ten minutes.

In order to compare separate subdivisions of the same standard we proceed as follows:—

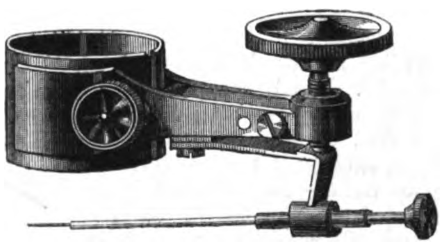
The stops are set e. g. equal to 1 decimetre. After the reading of the first decimetre has been taken as indicated above, the bar is

then moved along till the first line of the second decimetre forms a contact with the zero of the eye-piece micrometer, when at the same time contact is formed with the first stop. Moving the plate to the second stop the reading for the second decimetre is taken. A comparison of the several values obtained with the mean value will show how much each is in error, provided the entire length is correct.

Tolles' $\frac{1}{75}$ Objective.—Dr. Cutter gives some further particulars respecting this objective (made in 1873), in the 'Journal de Micrographie.'* It works both dry and immersion, is composed of three systems, and has 170° aperture. Its frontal distance is $\frac{1}{250}$ inch. The correction collar moves only $\frac{1}{8}$ of a circle. The aperture of the front lens is $\frac{1}{64}$ inch, and the "diameter of the objective at the other extremity" $\frac{1}{4}$ inch, its length being about $2\frac{1}{2}$ inch. The field is remarkably clear and very flat, the resolution good, and the definition, having regard to the enormous amplification, excellent.

Rezner's Mechanical Finger.†—This form was designed by Dr. W. B. Rezner, of Cleveland, Ohio, and is adapted to any Microscope, whereas the forms heretofore made were only designed for Microscopes having substages.

Fig. 2.



In use, the sleeve, seen in Fig. 2, is passed up over the objective far enough to have firm bearing, and so that the bristle point will be in focus when depressed nearly to its limit; it is clamped in place by the small thumb-screw. The wire in which the bristle is carried is drilled at the point to receive it, and slides easily, but not loosely, through a small sleeve, so that the end of the bristle can be brought into the centre of the field when in focus, and the wire can be revolved so as to view every side of the object picked up by the bristle. The wire stands at a greater angle than is shown in the cut, and the vertical part of the spring is not so long as figured.

When using the finger, the bristle is first raised by means of the micrometer screw till so far within focus as to be nearly or quite invisible, then the objective is focussed on the slide and the desired object sought for and brought to the centre of the field; the bristle point is then lowered by the screw till it touches the object, which

* 'Journ. de Micr.,' iii. p. 297.
† 'Am. Journ. Micr.,' iv. (1879) p. 65.

usually will adhere to it at once, and may be examined by rotating the bristle wire by means of its milled head.

Professor H. L. Smith, in a subsequent paper,* gives some hints which he thinks will greatly facilitate the use of the "finger," and which, though simple, are the fruit of long experience, will save much valuable time, and "conduce to general morality."

The "bristle" or "hair" is to be held in the spring forceps, and, after adjustment, a drop of sealing wax put on the forceps to bind all tight. To make the "hair," cut a slip of glass, and by a spirit lamp draw it out into a slender thread; snip off the thread by a knife, so as to present a bevelled edge (Fig. 3, magnified). This thread is so fine as to be quite flexible, and if dirtied can easily be cleaned. It is not affected

FIG. 3.

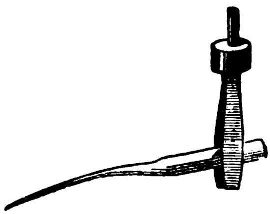
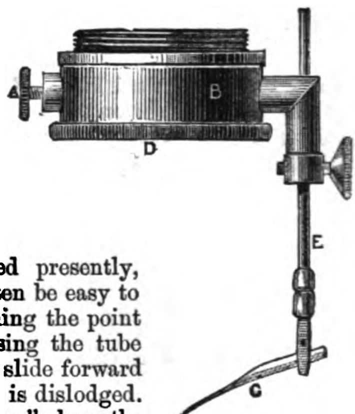


FIG. 4.



by moisture, applied as described presently, *a very important point.* It will often be easy to pick up a diatom by simply touching the point to the slide, and then by depressing the tube of the instrument, causing it to slide forward on the glass plate till the object is dislodged. His modification of the "finger" has the Society screw, and will receive any objective, though he prefers a $\frac{2}{3}$ inch. (Fig. 4.) When the screw A is loosened, the ring B and the hair C can be revolved, and made to point towards the centre of the field in any required direction, which will be found convenient for pushing a diatom into place in arranging. The objective screws in at D, and by raising or depressing the rod E, the point of the hair can be brought into focus. It should point downwards at a slight angle. If when it has been brought into focus, we unscrew the front lens of the objective slightly, this will throw the point out of focus, and now the objective may, by the rack, be brought down to give a distinct view of the material from which the object is to be picked, *without any danger of the hair point touching it.* When the object is found, then by turning home the unscrewed front lens, the point will come into focus, and by slightly racking down the tube, the point can be made to touch the object, and by racking back to lift it. If dirt is raised a light tap on the tube will instantly set it free, and leave the hair clean, or it may be cautiously wiped off with tissue paper. One of the greatest objec-

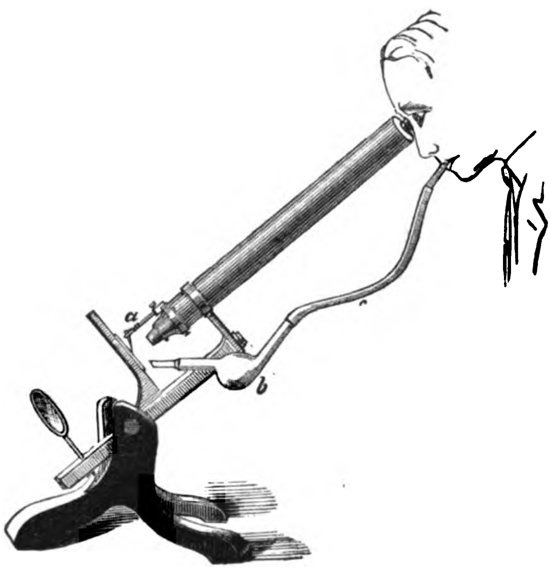
* 'Am. Journ. Micr.,' iv. (1879) p. 102.

tions to ordinary bristles, &c., is that after lifting a diatom, it is often impossible to make it let go, on touching the place where one wishes to deposit it, a difficulty rarely experienced with the glass hair. Although somewhat brittle, yet with care it may be used a long while, and can be easily replaced.

The material from which the selection is to be made is spread on a piece of thin glass, and heated red hot, if it contains diatoms, to burn out the organic matter; this piece of glass is attached to an ordinary glass slide, a little to the left of the centre; and to the right is put on the same slide the clean glass cover to receive the picked out specimens, and directly under the centre of this cover, on the under surface of the slide, a small ink dot, which can be easily recognized though out of focus, when, having secured the object on the end of the hair, the slide is pushed along to bring the cover into view. In this way one can readily pass from the crude material to the cover, without danger of detaching the specimen picked up. If the specimens are to be mounted in balsam, it is necessary to put a little thin solution of gelatine on the cover, and dry it.

With regard to the principal part of the manipulation, the method of taking off the object, just where and when we wish, and of arranging into lines, circles, &c.; this process is not his own as to idea; he has

Fig. 5.



reason to believe it is, substantially, that used by the professional preparers of these objects, though it has never before been made known. Fig. 5 shows the Microscope with the finger attached at *a*, and the hair just above the slide; *b* is a glass tube having a bulb, and

attached to the stand; a short bit of tube slides into the end nearest the stage, and may be drawn out till it nearly touches the slide; to the other end is attached a rubber tube *c* with a mouthpiece. When the object on the end of the hair is brought directly over where it is desired to be placed on the cover, the tube is carefully racked down till the object nearly touches the cover; now, by gently breathing through the tube, a film of moisture will form on the cover in the most beautiful manner if the tube be pointed right at its lower end, and will, if we stop breathing, again quickly disappear. Suppose now, we flood the cover with moisture, and depress the tube, the hair touching it, the object will be at once taken off, and by a little manipulation not easily described, but easily performed, and mainly consisting in so placing the hair by revolving the ring that its point, slipping forward on the glass, as the tube is depressed, will push the object here or there, into lines or circles, without danger of its flying off, or being again picked up, if we keep the cover moistened by gently breathing. It is astonishing how gentle a breath will flood the cover with moisture, and one must be very careful not to blow through the tube before the object is dislodged, or it will inevitably be blown away. When the moisture evaporates, as it will at once, the gelatine will hold all fast, and then there is no need of any heating of the cover, which might do harm by possibly charring the gelatine, only one must be sure it is really dry before placing it on the little drop of balsam on the slide. The bulb *b* catches the condensed moisture, and must be emptied occasionally.

Apparatus for Focussing Dissecting Microscopes.*—Herr Hilgendorf, of Berlin, suggests an arrangement to be worked by the *leg* for focussing dissecting Microscopes. These, as is known, strain the eyes, owing mainly to the necessity of using both hands in the dissecting process, which makes the constant adjustment of the focus irksome.

The inventor's apparatus (which can be at once applied to any instrument without the help of a mechanic) consists of a rather strong brass wire, 1½ mm. diameter, which at one end is hooked to the knee, and at the other is twisted round a cork, the latter being hollowed out in the middle, so that it can be pressed firmly over the adjusting screw of the Microscope. The wire should be bent at right angles 5 cm. from the screw; and then, by the raising or lowering of the leg, or side motion of the knee, it can be moved in the desired direction, and the focus varied. The flexibility and elasticity of the wire offer peculiar advantages, and do away with any complicated mechanism of levers and screws.

Improved Mounting for Cameræ Lucidæ.†—Professor L. Melassez suggests an improvement to the mounting of the cameræ lucidæ of Milne-Edwards, Nachet, and others.

These are fixed to the Microscope by means of a ring which encircles the tube, and on which they are jointed. The opticians

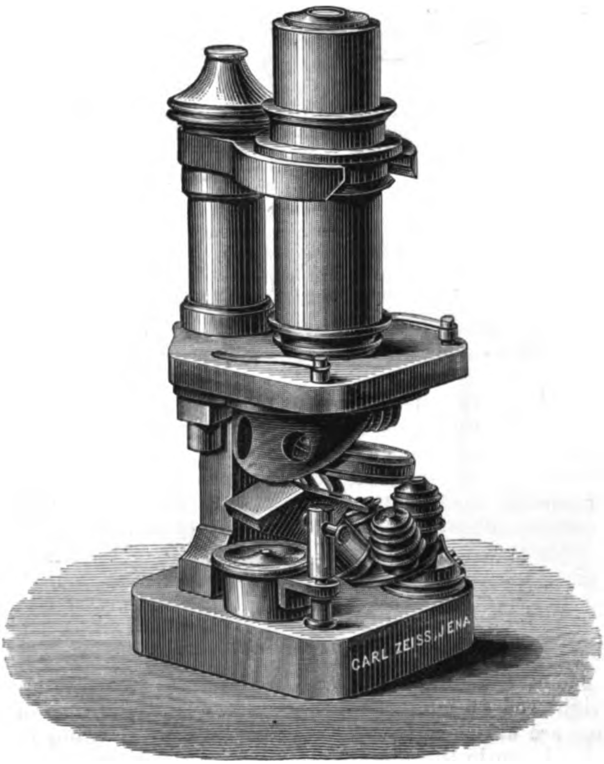
* 'SB. Gesell. Naturf. Freunde, Berlin,' 1878, p. 187.
† 'Travaux Laborat. Histol. Coll. France,' 1877-8 (1879) p. 117.

always place this joint at the *side*, so that the draughtsman cannot avoid knocking (his nose) against it, or else is obliged to give a very fatiguing inclination to the head. This inconvenience may be avoided by placing the joint not at the side, but at the *anterior part* of the camera.

In addition to this, the axis of movement is *vertical*, and when the camera is removed from the eye-piece, it is difficult to put it exactly back in the place it occupied, which is, however, very desirable. An axis with *horizontal* movement would be much better, and by such an arrangement the camera would be raised and lowered on the eye-piece like the cover of a box.

Zeiss' Travelling Microscope.—Fig. 6 represents the "Travelling Microscope" of Herr Zeiss, of Jena, which was exhibited at the November meeting of the Society.

Fig. 6.

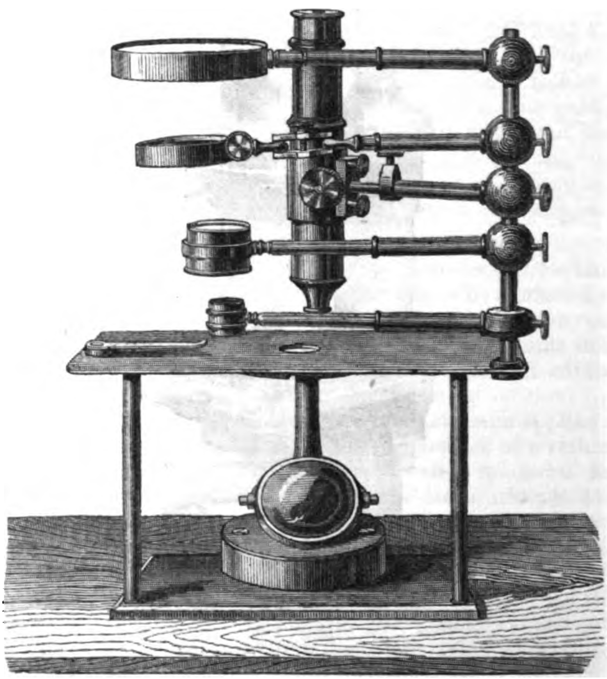


It consists of the Zeiss stand No. VI., the general construction of which is sufficiently shown by the woodcut; and it packs into a case $8\frac{1}{4}$ inches high by 4 inches square.

The tube can be readily replaced by a Brücke lens; the stage is hollowed out beneath, and has a concave diaphragm, shown in the foregoing figure, specially adapted to it. The four object-glasses are attached to a revolving "nose-piece," of exceptionally small size, which in packing can be screwed to the foot of the stand. The space beneath the stage is also utilized, in packing, for the Camera Lucida as well as the mirror. The latter is provided with universal movement by an extremely simple and ingenious arrangement. The upper part of the instrument with the stage can be turned round the optic axis.

Schöbl's Dissecting Microscope.*—This instrument, which is shown in Fig. 7, consists of a heavy brass base-plate (17 cm. by 12 cm.), on which is supported the stage (22 cm. by 12 cm.) by three uprights, the mirror being attached to one of them.

FIG. 7.



At one of the corners of the stage furthest from the observer is an upright rod 16 cm. high, to which five movable arms of $2\frac{1}{2}$ cm. diameter are attached, each arm being capable of being fixed by a screw, as shown in the figure. The lowest carries an aplanatic lens magnifying 30 times; the next, a similar lens, magnifying 15 times, the third, an ordinary dissecting Microscope, magnifying up to 150

* 'Arch. Mikr. Anat.,' xvii. (1879) p. 165.

times; and the fourth and fifth carry two other lenses of low magnifying power (7 and 3 times), the former having a jointed attachment to allow of the lens being placed in any position.

The arm carrying the Microscope is ordinarily turned away from the stage to the left of the observer, while the other arms which are not in actual use are placed forwards so as to be out of the way, but are at once available when required.

The inventor claims the following as the special advantages of the instrument:—

(1) The stage is entirely free for work, nothing being in the way of the observer's hands or head on the side at which he stands.

(2) It allows of a particularly rapid and convenient change of powers; and

(3) The preparation need never be moved from its place during work, and thus a great saving of time is effected.

Ward's Improved Microtome.—At the November meeting of the Society, an improved form of microtome was exhibited and described by Mr. F. H. Ward. It is a modification of the one introduced by Stirling, from which, however, it differs in the indicator. The thickness of the section is indicated by means of a screw having thirty-six threads to the inch, to which is attached a wheel containing thirty-five notches upon its circumference; into these notches a spring catch falls in rotation as the screw is turned. This spring is attached to a metal plate through which the screw works, but which is prevented from turning round with the screw by a brass rod fixed into the base of the microtome.

The bottom of the well is removable, and is retained in place by two bayonet catches. When removed from its fitting, the bottom is separable into two halves so as to release the screw. The continuity of the thread in the internal screw is maintained in the two halves when in position by means of two metal pegs on the face of one half accurately fitting into holes on the face of the other. The object of this contrivance is, that when the screw has been turned round to its extreme limit, by a slight backward turn the bottom of the well is removed, the two halves separated and the screw is set at liberty, thus avoiding the wear to the thread and the spring catch, which must inevitably result from rapidly turning the screw in the reverse direction through about two inches of its length.

A thick plate of glass, with an aperture the size of the well, covers the upper brass plate, and slides into position by means of a dovetail on each side.

Matthews' Section-cutting Machine.*—Dr. John Matthews has contrived a machine for making sections of such substances as bone, hard wood, ivory, nut, and other materials which are too hard to be cut with the section knife, and not of a nature to require the lapidary's wheel.

The carriage holding the saw runs smoothly yet firmly between friction rollers, and derives its reciprocating motion from a crank,

* 'M. Journ. Sci.,' i. (1879) p. 823.

which can be turned either by hand, or, when a higher speed is required, driven by a treadle and pulley. The saw is provided with adjustments to secure its parallelism and proper tension; the section is regulated by a screw of fifty threads to the inch, reading to thousandths by means of a micrometer head; the feed is either automatic by means of a cup, in which a suitable quantity of shot can be placed, acting by gravitation on a lever; or, as Dr. Matthews prefers, is capable of being regulated by hand. Owing to the steady motion of the saw when in proper adjustment, sections of suitable tissues can be cut as thin as the thousandth of an inch; the surfaces show no trace of the saw-cut, and are almost polished; very little after-treatment is needed to remove the few scratches left by the saw, and if required for mounting in balsam it can be done at once, taking the usual precautions to prevent penetration, and the consequent obliteration of structure.

Zeiss' $\frac{1}{18}$ Objective.—Colonel Woodward's views on this will be found at p. 988 of the 'Proceedings.'

Micrometry.—A reference to this subject will be found at p. 988 of the 'Proceedings.'

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PROCEEDINGS OF THE SOCIETY.

Meeting of 8th October, 1879, at King's College, Strand, W.C.
The President (Dr. Beale, F.R.S.) in the Chair.

The Minutes of the meeting of 11th June last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors.

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Coues, E., and J. A. Allen.—Material for a Bibliography of North American Mammals. 4to. Washington, 1877 ..	*Ditto.*
Cunningham, D. D., M.B.—On certain effects of Starvation on Vegetable and Animal Tissues. 47 pp., 11 figs. 4to. Calcutta, 1879	*The Author.*
Lanzi, Dr. C. M.—I Funghi della Provincia di Roma. (Extracted from 'Atti dell' Accademia Pontificia de' Nuovi Lincei.') 82 pp., 1 plate. 4to. Roma, 1879	*Ditto.*
Lewis, T. R. M. B.—The Microscopic Organisms found in the Blood of Man and Animals, and their relation to Disease. 91 pp., 3 plates, and 27 figs. 4to. Calcutta, 1879	*Ditto.*
Lyngbye, H. C.—Tentamen Hydrophytologiæ Danicæ. 248 pp., 70 plates. 4to. Hafniæ, 1819	*Dr. Millar.*
Reuss, J. D.—Repertorium Commentationum a Societatibus Litterariis Editarum. 2 vols. 574 pp. and 604 pp. 4to. Gottingæ, 1801–2	*Mr. Crisp.*
Schwann, Th., Manifestation en l'Honneur de M. le Professeur,—Liége, 23 Juin, 1878. Liber Memorialis. Publié par la Commission Organisatrice. 236 pp., and photograph. 8vo. Dusseldorf, 1879	*The Commission.*
Smithsonian Institution.—Annual Report of the Board of Regents for 1877. 8vo. Washington, 1878	*The Institute.*
University College.—Catalogue of Books in the General Library and in the South Library. 545 pp. and 536 pp. Vols. I. and II. A–C, D–N. 8vo. London, 1879	*The College.*
Beck's Revolving Microscope Table and Lamp	*Mr. J. Badcock.*
Slide of Scales of a species of the genus *Mormo*	*Mr. J. Beck.*
173 Mounted preparations (various)	*Representatives of the late Mr. C. Brooke, F.R.S.*
Photograph of Dr. A. Farre, F.R.S. (a Past President of the Society)	*Dr. Farre, F.R.S.*

	From
Clock for the Library	*Dr. Gray.*
Slide of *Peridinium cornutum*	*Mr. J. Levick.*
Diatomaceous Earth from the original find at Santa Monica* ..	*Mr. H. G. Hanks.*
Zircon Sand with Gold	*Mr. H. G. Hanks.*
Photograph (on Porcelain) of Prof. E. Abbe	*Mr. J. Mayall, jun.*
2 Slides of *Eucampia striata* n. sp. et var. *maxima*	*Dr. Stolterfoth.*
Ruling Machine	*Major Waterhouse, Representative of the late J. Waterhouse, F.R.S.*
13 Photographs (described at p. 672 of the Journal)..	*Col. J. J. Woodward.*

On the motion of the President, special votes of thanks were accorded to Mr. Badcock, the representatives of the late Mr. Chas. Brooke, Dr. Gray, and the representatives of the late Mr. J. Waterhouse, for their respective donations.

Mr. Crisp mentioned that during his absence abroad the paper at p. 653 of the October number of the Journal had been printed from the author's original MSS. instead of from the revised MSS., for which it had been held over. The corrected pages would be supplied with the next number.

The following Note from Mr. Wenham was taken as read:—

As statements have been made to the effect that I altogether deny the possibility of obtaining an angle on a balsam-mounted object beyond 82°, the following references will show that, excepting under certain conditions, I have not made such an assertion, which, as it appears recorded with my name attached in the 'Proceedings' of the Society, calls for a notice that it would not otherwise have received from me.

I must therefore state positively, that I never held, and do not hold, any such opinion. The discussion has been long and not very definite, and sufficient attention may not have been given to particulars by some attributing this error to me—to be excused for this reason.

In 'Quart. Journ. Micr. Science,' vol. iii. (1855) p. 303, for the purpose of remedying the loss of aperture on an object in balsam from a dry object-glass, I describe the adaptation of an additional lens in front connected with the cover by a refractive intermedium, thus securing the full effect of aperture.

In 'Monthly Microscopical Journal,' vol. v. (1871) p. 17, I state that "An angle of 82° cannot be exceeded in a dry objective,

* The bottle in which this was sent was broken in transit through the post, and the contents had disappeared.

nor can it be greater on the immersion system, where an interchange of front adapts it to both conditions."

In vol. v. p. 118 the following sentence has been referred to:— "I challenge anyone to get through the object-glass with the immersion front a greater angle, or any portion of the extraneous rays that would in the other case be totally reflected, as no object-glass can collect image-forming rays beyond this limit." At the top of this same page I show distinctly that this remark applies to a dry lens, and the whole article bears reference to a former one (vol. v., page 23), with diagrams used for objectives used on dry objects, or such as those generally in use at that time.

Mr. Tolles having claimed 100° or more of aperture for an immersion lens, in vol. vi. (1871) p. 85 I point out the cause arising from an error in the means of measurement. On the next page I give a series of measurements of the angles of objectives immersed in water, all of which were within the corresponding balsam limit of 82°. Again this referred to the then usual form of objectives that could be used dry.

In vol. vii. (1872) p. 272 I say, "Mr. Tolles has accepted the only condition under which the full aperture can be brought to bear on a balsam-mounted object, viz. that of the tiny hemispheres. I am glad of his announcement that he has succeeded in this, and should like to see the same thing done in this country, particularly with large aperture glasses, say higher than $\frac{1}{8}$th."

In vol. ix. (1873) p. 268 Colonel Woodward having measured the Tolles $\frac{1}{10}$ referred to in the previous controversy, finds the balsam angle only 76°. On p. 270 he continues, "I subsequently extended the measurements to the immersion $\frac{1}{15}$ and $\frac{1}{18}$ by Mr. Tolles belonging to the Museum, and found that the maximum balsam angle was less than 80°. These results, it will be seen, fell within the limits laid down as possible by Mr. Wenham."

In vol. ix. (1873) p. 273 there is a memorandum by Professor Keith, in which he says, "Mr. Wenham's experiments alluded to in his article in the 'Monthly' for January, indicate an explanation, and it seems singular that they did not suggest to him long ago a method of obtaining what Mr. Tolles has obtained—an objective of large angle for objects covered in balsam." Professor Keith's accompanying diagram exactly explains the principle, and is just the same in effect as that of my additional front lens, described and illustrated in 1855, showing that he had not found leisure to look into former points of the question. My diagram is illustrative of Mr. Tolles' subsequent 4-system immersion objectives, the focus being nearly in the centre of the radius of the front lens in both cases.

In vol. x. (1873) p. 12 I say, "I trust that Colonel Woodward having affirmed 'that the position taken by me is certainly true, for objectives as ordinarily constructed,' will allow that this additional lens embodies a deviation from the original question, which was to the effect that there would be no loss of angle aperture of ordinary objectives by the immersion of the front surface in fluids."

As regards the latter phase of the discussion, relative to false

or true apertures, and the best form of apertometer or means of measurement, that is a different branch of the question not as yet concluded.

It will save much confusion if we take Colonel Woodward's recent suggestion* for the nomenclature of the angle of immersion lenses, and instead of water, glycerine, oil, or balsam angles to take the degrees of the primary angle, or that *within* the body of the front lens, of immersion object-glasses, and call it "*interior angle*." The varied exterior angles in the above fluids will then follow and be known by their relative refractive indices. The stumbling-block of 180° (which may mean 82° only in the front lens) will then be entirely cleared away.

Mr. J. Beck read a paper, "Note on the Structure of the Scales of a species of *Mormo*," slides of which were exhibited under the Microscope (see p. 810).

Mr. Crisp expressed a hope that the Fellows would look at the scales at the close of the meeting, as they seemed to furnish a convincing proof of the truth of Mr. Beck's theory.

Dr. Edmunds said that some time ago he had given attention to the Podura scale, and found that he could not determine on which side of it the minute plumules seemed to grow, the scale being so extremely thin and so transparent. He could not, however, help thinking that if they watched the scale very carefully with some kinds of dark-ground illumination, dry, and with the cover hard down upon the scale, they would get appearances which were wholly irreconcilable with the theory put forward by Mr. Beck. In this way they got the "featherlets" projected out of the membrane, giving a beautiful brush-like appearance. Then, if they had the scale mounted in balsam and illuminated by highly oblique light, they would get an appearance almost identical with that which was seen in the former instance; they lost all the hyaline appearance of the scale itself, and saw these featherlets becoming an independent source of light, standing up illuminated from the surface of the scale.

Mr. Beck said he based the statements in his paper entirely independently of what anyone could *see*, because they might see anything according to the way they looked at it. They must rather *reason* according to the nature of the structure they were viewing. In this case they were looking at two membranes united together, but which could be taken apart. They could run moisture up and down on the lower external surface, but could not do so on the upper surface, which was thus shown to be almost smooth. They therefore had a complex substance to deal with, and it was necessary to reason as to what that structure was composed of. Now, considering the whole class of these scales from those of *Lepidocyrtus* down to those of *Lepisma* and others, if they could satisfactorily connect the one with the other, and could show that the appearances could be produced by regular corrugations, then it was much more consistent to

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 277; this Journal, *ante*, p. 783.

say that they were all modifications of the same structure, and that nature had provided a number of corrugations for the purpose of strengthening the scale, rather than plumules which would be of no use whatever so far as they could see.

The President inquired if Mr. Beck had observed all the markings on the scales of Lepidoptera to be on the under surface of the scale?

Mr. Beck said he could not say that they were, but certainly they were so in the Thysanuræ. He had not tried the Lepidoptera, but his impression was that they would be found the same.*

The President suggested that the object of this structure might be to prevent the scales from adhering together, since, looking at it from an engineering point of view, there seemed to be far more of these corrugations than were required for the purpose of strengthening the scales.

Mr. W. H. Gilburt read a paper "On the Morphology of Vegetable Tissues," the subject being illustrated by drawings, some of which were enlarged upon the blackboard (see p. 801).

Mr. Stewart said he had listened to the paper with very great interest, as it teemed with original and striking observations, and he was sure that all present would agree that it dealt in a masterly manner with a very important subject, that of how structure was gradually built up. As Mr. Gilburt's views differed so much from those hitherto held on the subject, he thought it would be very desirable that some one should go over the ground again, so as to verify the observations, in which case he would suggest that the cell substance should be taken into consideration as well as the cell outline.

Dr. Stolterfoth's paper "On a new Species of the Genus *Eucampia*" was read by Mr. Stewart (see p. 835).

Mr. Crisp reminded the Fellows that Mr. Bolton's living organisms were always available at the Wednesday Evening Meetings, and had recently been of the greatest interest, including the discoveries that had been made during the vacation by Mr. Levick, Mr. Bolton, and other members of the Birmingham Natural History and Microscopical Society, consisting of *Leptodora hyalina* and *Hyalodaphnia Kahlbergensis* (see p. 877), *Anuræa longispina* (see p. 879), and the new genus of Rhizopods—*Lithamœba discus*, Lankester (see p. 900).

The visit to this country of an illustrious Ex-officio Fellow of the Society, Professor Haeckel, of Jena, was also referred to, which having unfortunately been made during the recess, had rendered it impossible to welcome him.

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* See Note to the paper on p. 810.

The following Objects, Apparatus, &c., were exhibited:—

Mr. Beck:—Slides of *Mormo* to illustrate his paper.

Mr. Bolton:—*Leptodora hyalina* and *Hyalodaphnia Kahlbergensis*.

Mr. Crisp:—(1) Nachet's Portable Demonstrating Microscope (*ante*, p. 766). (2) Professor A. de Lasaulx's Mineralogical Microscope (see 'Bull. Soc. Belg. Micr.,' iv. (1878). (3) Fletcher's Microtome (*ante*, p. 466). (5) Roy's Microtome (*ante*, p. 768). (6) Beck's Volute Turntable. (7) Sidle's Congress Turntable. (8) Diego's Turntable. (9) Bulloch's Cox's Turntable. (10) Rezner's Mechanical Finger (*ante*, p. 951).

Mr. Gilburt:—Sections through Cambium and Procambium, to illustrate his paper.

Mr. Guimaraens:—Slides of Zoological and Botanical subjects, prepared by Dr. Marsh, of St. Helens.

Dr. Stolterfoth:—Two slides of *Eucampia striata*.

Mr. F. H. Ward:—Section of wood ("Bois nephritique").

Col. Woodward:—Thirteen photographs of *Amphipleura pellucida* (*ante*, p. 672).

New Fellows.—The following were elected *Ordinary Fellows*:—Professor P. Martin Duncan, M.B. (Lond.), F.R.S., &c., and Messrs. D. B. Cazaux, T. G. Lyon, and A. C. Mercer.

MEETING OF 12TH NOVEMBER, 1879, AT KING'S COLLEGE, STRAND, W.C. THE PRESIDENT (DR. BEALE, F.R.S.) IN THE CHAIR.

The Minutes of the meeting of 8th October last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors, viz.:—

Nachet's Binocular Microscope (older form)	*Mr. Crisp.*
Graham Compressorium, for use with the Paraboloid	*Mr. W. Graham.*
Twelve Slides of the Diatomaceous Earth from Santa Monica, which was sent by Mr. Hanks, mounted by Dr. Gray from the scrapings of the broken pieces of the bottle, and the paper in which it was wrapped (see p. 983)	*Dr. Gray.**

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* Dr. Gray writes that Fellows interested in the matter can have a mounted slide of the Santa Monica deposit by applying and sending a postal box to the Assistant Secretary. Dr. Gray will only be able, however, to comply with a moderate demand, and will not mount any until he knows how many will be required.

Mr. F. H. Ward briefly described a microtome designed by him and exhibited to the meeting (see p. 957). Some sections of wood cut with this apparatus were shown under one of the Microscopes on the table.

Mr. Crisp, in exhibiting Zeiss's travelling Microscope, called attention more particularly to the very light quadruple nose-piece and the ingenious arrangement for giving universal movements to the mirror (see p. 955).

Mr. Beck remarked that the weight of English quadruple nose-pieces was not so much in the nose-piece itself as in the objectives it had to carry.

Mr. Gilburt made a short communication supplementary to his paper read at the last meeting, the substance of which will be found appended to the paper in a foot note at p. 806.

Colonel Woodward's "Note on certain Amplifiers of Zeiss as compared with those of Tolles," was read by Mr. Crisp, and the photographs of *Amphipleura pellucida* taken by both were laid on the table. The note also contained some remarks on the use of chloride of cadmium as an immersion fluid, especially for micro-photographic purposes, which will be found at p. 943. With regard to Zeiss's $\frac{1}{18}$, Colonel Woodward said, "I must add my testimony in favour of the exceedingly satisfactory performance of the new $\frac{1}{18}$ by lamplight, not merely on lined test-objects, which it displays in a more striking manner than even the $\frac{1}{12}$, but especially on such objects as white blood-corpuscles, and similar living tissue elements, bacteria, and the like, for the study of which it appears to me especially suited."

Dr. R. H. Ward's letter as to the matters to be brought before the National (American) Committee on Micrometry, was read.

Mr. Beck said it seemed to him that the important practical question which they wanted to determine was whether the scales which they did use were correct. If they had one from Paris, and another from Holland, they would find both of them to be incorrect. Some means was therefore desired by which they could be tested as to correctness.

Mr. Crisp referred to the paper by Professor Rogers on "Comparators for Measures of Length," which will be found at p. 947.

Mr. A. D. Michael pointed out that it seemed doubtful if there was in existence a really true standard metre.

Mr. Beck said he was not speaking of such minute variations as those which came into considerations of that kind, but of tests as they concerned the practical Microscopist. The question of the absolute length of a metre dealt, he thought, with matters of far greater minuteness than there was any real necessity to take notice of.

Mr. Teesdale referred to the instrument designed by Professor Suringar, of Holland, for testing the accuracy of micrometers, which was exhibited at the loan collection of scientific instruments at South Kensington.

Mr. Forrest's paper "On the Anatomy of *Leptodora hyalina*," was read by Mr. Crisp, the figures in illustration being enlarged upon the blackboard by Mr. Stewart (see p. 825).

Mr. J. Fullagar's Note on a curious fresh-water organism, which he had discovered, was read by Mr. Crisp, together with a letter from Mr. Saville Kent, who said that as far as he could judge it was closely allied to the marine *Freia ampulla* of Claparède and Lachmann, the tubes in one specimen having been apparently deserted by the Infusor and occupied by Rotifer, and promising to give a more precise determination on the receipt of living specimens.

Mr. Stephenson's paper "On a Table of Numerical-Apertures, showing the Equivalent Angles of Aperture of Dry, Water Immersion, and Homogeneous Immersion Objectives, &c.," was taken as read (see p. 839).

Mr. Mayall's paper "On an Immersion Stage Illuminator," was read by Mr. Crisp, and the apparatus which it described exhibited (see p. 837). Another paper, "Aperture Measurements of Immersion Objectives expressed as 'Numerical-Aperture,'" was taken as read (see p. 842).

Mr. Crisp read various letters and other communications received from provincial and foreign societies in connection with the Ex-officio Fellowship.

The President announced that the first Scientific Evening of the session would be held on December 3rd, in the Library of King's College.

The following Objects, Apparatus, &c., were exhibited:—

Mr. Badcock:—Abnormal forms of *Acinetæ*.

Mr. Bolton:—*Ophrydium versatile*, and *Limnias ceratophylli*.

Mr. Crisp:—(1) Zeiss's travelling Microscope (see p. 955). (2) Improved apparatus for counting blood-corpuscles (see p. 944).

Mr. Forrest:—Two slides of *Leptodora hyalina*.

Mr. Graham:—New compressorium.

Mr. Mayall, jun.:—Stage immersion illuminator.

Mr. Ward:—(1) Improved microtome (see p. 957). (2) Sections of wood of *Antiaris toxicaria* (upas tree of Java); double stained.

New Fellows.—The following were elected *Ordinary Fellows*:—Professor F. Jeffrey Bell, B.A.; Dr. C. F. Fischer; Rev. J. E. Vize, M.A., and Messrs. A. G. H. Gibbs, W. H. Gilburt, T. S. Goodall, W. Graham, W. Joshua, G. Williams, and S. King Wilson, M.R.I.

Honorary Fellows:—A. Agassiz, Cambridge (Mass.), U.S.; G. Balbiani, Paris; O. Bütschli, Heidelberg; L. Cienkowski, Kharkoff; P. T. Cleve, Upsala; M. Cornu, Paris; A. Dodel-Port, Zürich; Th. W. Engelmann, Utrecht; H. Frey, Zürich; E. Metschnikoff, Odessa; W. Nylander, Paris; C. A. J. A. Oudemans, Amsterdam; G. O. Sars, Christiania; F. E. Schultze, Graz; J. J. S. Steenstrup, Copenhagen; E. Strasburger, Jena; F. de Thümen, Klosterneuburg (Austria); Ph. van Tieghem, Paris; E. Warming, Copenhagen; A. Weismann, Freiburg, i. Br.; and K. A. Zittel, Munich.

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